

**GUIDE TO SELECTED GEOLOGICAL FIELD SITES IN FRANKLIN AND
DELAWARE COUNTIES, OHIO**

A Senior Thesis
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The Ohio State University

By

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Approved by

A handwritten signature in black ink, appearing to read "Garry D. McKenzie", written over a horizontal line.

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ABSTRACT

The city of Columbus and the area to the North of it are rapidly expanding. It is hard to believe that there are still so many geologic sites of interest to be seen in the area. Information on where these sites are located is difficult to find, so this paper will be a guidebook to selected sites of geological interest in Franklin and Delaware Counties.

Much of Ohio is covered in glacial till deposited by the last ice age. Areas that are not covered in till, show outcrops of the underlying bedrock. This bedrock ranges in age from Late Silurian to Early Mississippian (410 – 360 mya). The bedrock units to be studied are, stratigraphically from oldest to youngest, the Salina Group, the Columbus Limestone, the Delaware Limestone, the Olentangy Shale, the Ohio Shale, the Bedford Shale, the Berea Sandstone, the Sunbury Shale, and the Cuyahoga Formation. The sites chosen to view these units are spread throughout Franklin and Delaware Counties and include many parks as well as some private property such as schools and businesses. Directions and contact information for each site are given.

ACKNOWLEDGEMENTS

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I would also like to thank all those who helped me in my search for information regarding the geology of Central Ohio and the locations at which this geology can be seen. They include Ernie Slucher, Glenn Larsen, Gregory Schumacher, and Scott Brockmann at the Ohio Department of Natural Resources, Division of Geological Survey; Dr. Loren Babcock at The Ohio State University, Geological Sciences Department; and Dr. Hallan Lescinsky at Otterbein College, Earth Sciences Department.

My thanks also go to the people at the specific sites who provided me with more information about the exact locations and types of features. They include the Naturalists at Highbanks Metro Park and Blendon Woods Metro Park, and Garry Getz at Marble Cliff Quarry.

I also want to thank David Wojnowski at the Ohio School for the Deaf, Chuck Howard at Camp Lazarus, and again, Garry Getz at Marble Cliff Quarry for giving permission for visitors to access these sites, and to Peg Hanley for giving me permission to reproduce parts of the Metro Parks brochures.

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Introduction

With the Columbus Metropolitan area being so large and continually growing, it is difficult to imagine that there are so many geological features to be seen in the area. In Franklin County, where Columbus is located, and in Delaware County, just to the north, there are numerous bedrock outcroppings as well as several places where the remaining effects of the last glacial period can be seen. Information about where to find these spectacular geological features is not readily accessible. To some degree, this is due to outdated information as a result of the fast-paced growth this area has experienced in the recent past and is still currently experiencing. Also, much of the limited information is not assembled into one easy reference. The primary objective of this paper is to provide a source of selected field sites for teachers and educational groups who are interested in studying the rocks that form the foundation of the Columbus area. Many of these sites can also be visited by families with an interest in the natural beauty that surrounds them everyday here in the Columbus area.

The sites in this guide include bedrock features from the Late Silurian Period to the Early Mississippian Period, as well as glacial features left from the last Ice Age. The bedrock ranges in age from over 410 mya to less than 360 mya, and is all composed of sedimentary rocks. There are nine rock units that will be described and can be seen at the sites in this guidebook. The oldest is the Salina group, which is Late Silurian in age. The next six units are all now considered to be of Devonian age. They are, from oldest to youngest, the Columbus Limestone, the Delaware Limestone, the Olentangy Shale, the Ohio Shale, the Bedford Shale, and finally, the Berea Sandstone. Above these units lie the only two rock units of Mississippian age visible in the selected study area. They are the Sunbury Shale and the Cuyahoga Formation. The relationship between these units can be seen in the stratigraphic column shown in Figure 1. These rocks are in many places covered by glacial deposits left from the Wisconsinan glacial period that ended about 14,000 years ago. (Hansen, 1984) These deposits vary in thickness from 0 to around 300 ft throughout Franklin and Delaware Counties.

This guide selects 15 sites throughout Franklin and Delaware Counties at which the before mentioned rock units can be seen either at a distance or in some cases, close enough to be able to study the rocks in detail. Most of the sites are within parks or other public areas. A few sites are on private property and will require advance permission and/or some sort of notification that you will be visiting. All the sites will list contact information if required.

Geology and Geologic History of Central Ohio

Franklin and Delaware counties lie in a region of Ohio called the Central Lowlands. Most of the surface here is covered by glacial till deposits left by the most recent glacial period, the Wisconsinan, which ended about 14,000 years ago. Till is the name given to glacial sediment composed of unsorted boulders, dirt, and rock fragments deposited directly by ice. (Hansen, 1984) Please see Appendix for more information

about the geological history of Ohio and information concerning the glacial deposits of the selected area of study.

In areas not covered by glacial deposits, bedrock outcrops can be seen that are all sedimentary in nature. There are two types of sedimentary rocks, detrital and chemical. Detrital rocks are formed by the "accumulation of material that originates and is transported as solid particles derived from both mechanical and chemical weathering." (Tarbuck and Lutgens, 1999, p 145) Rocks that are at the Earth's surface are affected by the climate that surrounds them. Rocks are broken down over time both by weathering caused by climatic factors and moisture, as well as by water flowing over them. The particles that are formed by these erosional processes can be swept into creeks and rivers and then carried downstream where they will eventually be deposited in some calm body of water such as a lake or ocean, or on a river floodplain. As more sediment is deposited, the lower particles become buried and get compacted by the weight of overlying layers, and become lithified. Sedimentary rock can also form when the particles that have been laid down are cemented together by minerals coming from water moving through the sediments. Some types of rocks formed by this process are shales and sandstones. Chemical sedimentary rocks, such as limestone and chert, are derived from material that is carried to lakes and oceans in solution. The materials then precipitate either inorganically by processes such as evaporation, or organically by being extracted by water-dwelling animals and plants to form shells and other hard parts. After these organisms die, their skeletons accumulate on the floor of the lake or ocean, are buried, and become cemented together or are otherwise lithified. The buried rocks may then be uncovered by erosion as parts of the crust are up lifted by tectonics and are returned to the surface of the Earth where they can be seen today. The rock layers underlying the Columbus area were lifted and tilted slightly down and eastward so that the rocks that are outcropping form North-South bands that generally get younger in age as you travel from West to East across the state (See Appendix).

The sedimentary rocks that outcrop in the Franklin and Delaware County areas range from Late Silurian to Early Mississippian in age. During this time, Ohio was covered by shallow epeiric seas of the Appalachian Basin. Fluctuations in sea level allowed for the deposition of the limestones, shales and sandstones that are currently visible. The ages of these periods are Silurian Period – 440 to 410 mya, the Devonian Period – 410 to 360 mya, and the Mississippian Period – 360 to 325 mya. The Mississippian Period is part of the Carboniferous Period.

Salina Group –The oldest rock that outcrops in the selected area formed during the Silurian Period (440 – 410 million years ago). The rocks, originally called the Monroe Formation (Stauffer, 1911), are now considered to be part of the Salina group. This formation is "a fine-grained compact drab limestone or dolomite which is rather thin-bedded and has a distinctly banded structure." (Stauffer, 1911, p. 17). The Monroe Formation does not generally contain many fossils, and there are exceptionally few in the Columbus area. Only a small fraction of the total unit thickness is visible in the area. This makes it very difficult to find it outcropping naturally. The only site in this book where you can see any good amount of this formation is at the Marble Cliff Quarry, where it is beginning to be quarried.

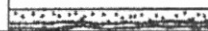
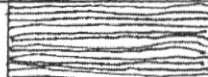
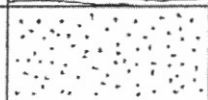

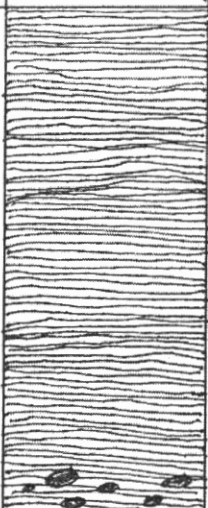

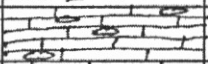


System	Formation	Section	Thickness in feet	Character of rocks
Mississippian	Cuyahoga Formation		20 exposed	Fine-grained bluish sandstone alternating with soft bluish-gray shale
	Sunbury Shale		20-60	Fissile black bituminous shale
Devonian	Berea Sandstone		65-80	Gray to buff sandstone
	Bedford Shale		70-100	Reddish-brown to chocolate-brown shale with thin layers of sandstone
	UNCONFORMITY			
	Ohio Shale		250-400	Dark brown to black fissile bituminous shale containing large spheroidal concretions in the lower portion
	UNCONFORMITY			
	Olentangy Shale		30-35	Soft blue calcareous shale
	UNCONFORMITY			
Silurian	Delaware Limestone		0-45	Bluish-brown, clay-rich, cherty limestone
	UNCONFORMITY			
	Columbus Limestone		80-105	Upper part gray semicrystalline limestone; lower part massive brown crystalline dolomite
	UNCONFORMITY			
Silurian	Salina Group		100 exposed	fine-grained compact drab limestone or dolomite which is rather thin-bedded and has a distinctly banded structure

Figure 1 – Stratigraphic column of the rocks exposed in the studied area.

Scale: 1 inch = 160 feet

Above the Salina group lies the Columbus Limestone. The contact between these two rock units is unconformable. This means that after the sediments that formed the Salina Group were laid down, they were exposed and partially eroded some time before the deposition of the Columbus Limestone. The amount of time that occurred between the end of the deposition of the Salina Group and the beginning of the Columbus Limestone is not known. In this particular formation, the rocks were lithified, or already solid rock, before they were acted upon by erosion. This is known because in places a basal conglomerate consisting of Columbus Limestone with pieces of the Salina Group within it is found. These pieces would have only been preserved this way if the Salina Group rocks had already been solidified into rock before they were acted on by erosion. The contact between these two rock units is considered to be the Silurian – Devonian boundary.

Columbus Limestone – The Devonian Period lasted from 410 – 360 million years ago. Most of the rest of the rocks that are visible in central Ohio are from this period. The oldest of the Devonian rocks, as mentioned before, is the Columbus Limestone. This limestone is fairly pure and ranges in the Columbus area from approximately 80 to 105 feet in thickness. The name, Columbus Limestone, was chosen because when it was described, it was already being quarried in the Marble Cliff Quarry in Columbus. It has been used as a building stone for many buildings throughout the area because of its durability. This unit is very fossiliferous in places. Corals, brachiopods, mollusks, and fish fossils are abundant in this unit (Stauffer, 1911). See the Appendix for examples of some of these organisms. The upper 6 – 8 inches of the formation is generally referred to as the “bone-bed”. This layer is highly fossiliferous but most specimens are not good quality. Some possible explanations for the numerous fragments of fossils found there are that it could have been an exceptionally good feeding place or that there was a mass extinction event. The Columbus Limestone is generally massive in bedding and is light gray to light brown in color. The lower portion, the Bellepoint Member, is a brown dolomite which is highly crystalline. The upper portion, the Delhi Member, is a limestone which is light gray in color, and is medium to massive in bedding. The texture of this section is fine and dense (Stout, 1943).

The contact between the Columbus Limestone and the unit above it is unconformable. The loss of time is not visible just by looking at the outcrop. The decision to call this contact unconformable is based on a gap in the fossil record showing a loss of time (Ernie Slucher, personal communication). This may have been caused by erosion or by nondeposition of sediment.

Delaware Limestone – The Delaware Limestone consists of a light blue limestone with some brown shaly limestone beds in it. The clay content of this unit is much higher than in the Columbus limestone. There are also several bands of chert nodules within this unit. The Delaware limestone is somewhat similar to the Columbus Limestone in that they are both fine grained and contain fossils. There are fewer species present in this unit as compared to the number of species present in the Columbus Limestone. Also in this unit, there occur species of fossils that do not occur in the older Columbus Limestone. See the Appendix for examples of Delaware Limestone fossils. The bedding of this unit is typically less than a foot, and the thickness ranges from 0 feet in the southern portion

of the selected area, to approximately 45 feet in the northwest portion (Westgate, 1926). In the past, the Delaware Limestone was quarried for use as a building stone.

The contact between the Delaware Limestone and the overlying Olentangy Shale is very sharp in some places and appears to be gradational in others. Even though there is no easily recognizable evidence of an unconformity in Delaware County, the contact between the Delaware and the Olentangy is considered to be unconformable. If looked at in a broader sense throughout areas further to the south of Delaware County, the Olentangy rests on the Delaware, then the Columbus, then later, the Salina group. This shows that there must be an unconformity, if not in Delaware County, at least in other places further to the south.

Olentangy Shale – The Olentangy Shale ranges in thickness from about 30-35 ft. Like the Columbus Limestone, it thins as one moves from the northeast towards the southern portion of the unit. It consists of a blue-gray mudrock that is very soft and has indistinct bedding (Hellstrom and Babcock, 2000). The mudrock also contains some black shale beds as well as concretionary nodules and layers of gray limestone. The contact between the Olentangy Shale and the overlying Ohio Shale is “disconformable to possibly conformable in places” (Hellstrom and Babcock, 2000).

Ohio Shale – The Ohio Shale is a fissile dark gray to black shale that is rich in organic material. It likely formed in a shallow, relatively stagnant offshore marine basin (Feldmann, 1996). When broken apart, the rock has an oily smell. Thickness is greatest in north eastern Ohio and thins rapidly towards the south and west (Hansen, 1994). In central Ohio, the Ohio Shale is divided into three members. These members are from oldest, the Huron Shale Member, the Chagrin Shale Member, and the Cleveland Shale Member. The total thickness of these members in the selected area averages about 375 ft (GSO structure contour maps). Large concretions can be found within the Huron Shale Member. They are composed of limestone or dolomite and range in diameter from a few inches up to a few feet. The centers of these almost spherical concretions are typically a fossilized fish bone or piece of fossilized wood. The beds of the shale above and below the concretion are bent around the concretion. This suggests that the concretions are secondary products formed by the aggregation of material around the nucleus after deposition of the shale.

Bedford Shale – The next youngest rock of Devonian age is the Bedford Shale. It lies conformably above the Ohio Shale. This shale is very soft and varies in color from a bluish gray to a red or chocolate brown. One characteristic of the upper portion of this unit is the disturbed condition of the sediments. The layers are frequently contorted and sometimes crushed while the overlying Berea sandstone layer is affected very little or not at all (Stauffer, 1911). One possible explanation for this is that the sediments were deposited on steep marine slope and that slumping or superficial faulting occurred. The thickness of the Bedford is approximately 70-100 feet (GSO structure contour maps).

Berea Sandstone – The Berea is youngest formation of Devonian age in central Ohio. It is a coarse siltstone to very fine sandstone and varies in thickness. The thickness in this

unit is 65-80 feet near Sunbury in Delaware County and thins towards the southern portion of the selected area. The color of this unit is a light gray to buff color. The contact with the underlying Bedford Shale is conformable. The Berea fills in ravine-like structures in the Bedford. This may seem to show an unconformable contact between these two units, but actually they are conformable. The Berea shows cross-bedding and ripple marks which suggest that it was deposited in a marine deltaic environment which cut down into the Bedford as the Berea was being deposited. The varying thicknesses of the layer show different lobes deposited as the source of the incoming sediment changed position over time.

Sunbury Shale – The Sunbury Shale is a black, bituminous shale that is very fissile, and somewhat resembles the Ohio Shale. Its contact with the underlying Berea Sandstone is conformable and sharp. The thickness of this unit ranges from around 60 feet in the northeast portion of Delaware county (GSO structure contour maps), to less than 20 feet in the Columbus area (Stauffer, 1911). The lower part of the Sunbury is often quite fossiliferous although the number of species is small and are generally ones associated with black shale conditions (Stauffer, 1911). It is the oldest of the Mississippian age rocks found in this area, forming approximately 360 to 350 mya.

Cuyahoga Formation – The youngest rock that outcrops in the selected area, the Cuyahoga Formation is composed of fine-grained sandstones alternating with clay-rich shales, all usually bluish in color. This rock is Mississippian in age and contains a variety of trace and body fossils (Willis, 1996). The contact between the Cuyahoga Formation and the Sunbury Shale is conformable. The thickness of the Cuyahoga, at the site selected in this guidebook to see this unit, is just over 20 feet.

SITE LISTING

Delaware County

1. Blue Limestone Park, Delaware
2. Camp Lazarus
3. Highbanks Metro Park
4. Olentangy Indian Caverns

Franklin County

5. Blendon Woods Metro Park
6. Fountain Square – Earth Day Monument
7. Hayden Run Falls Park, Columbus
8. Hoover Dam
9. Marble Cliff Quarry
10. Ohio School for the Deaf
11. Orton Hall
12. Pickerington Ponds Metro Park
13. Pine Quarry Park, Reynoldsberg
14. Walhalla Ravine

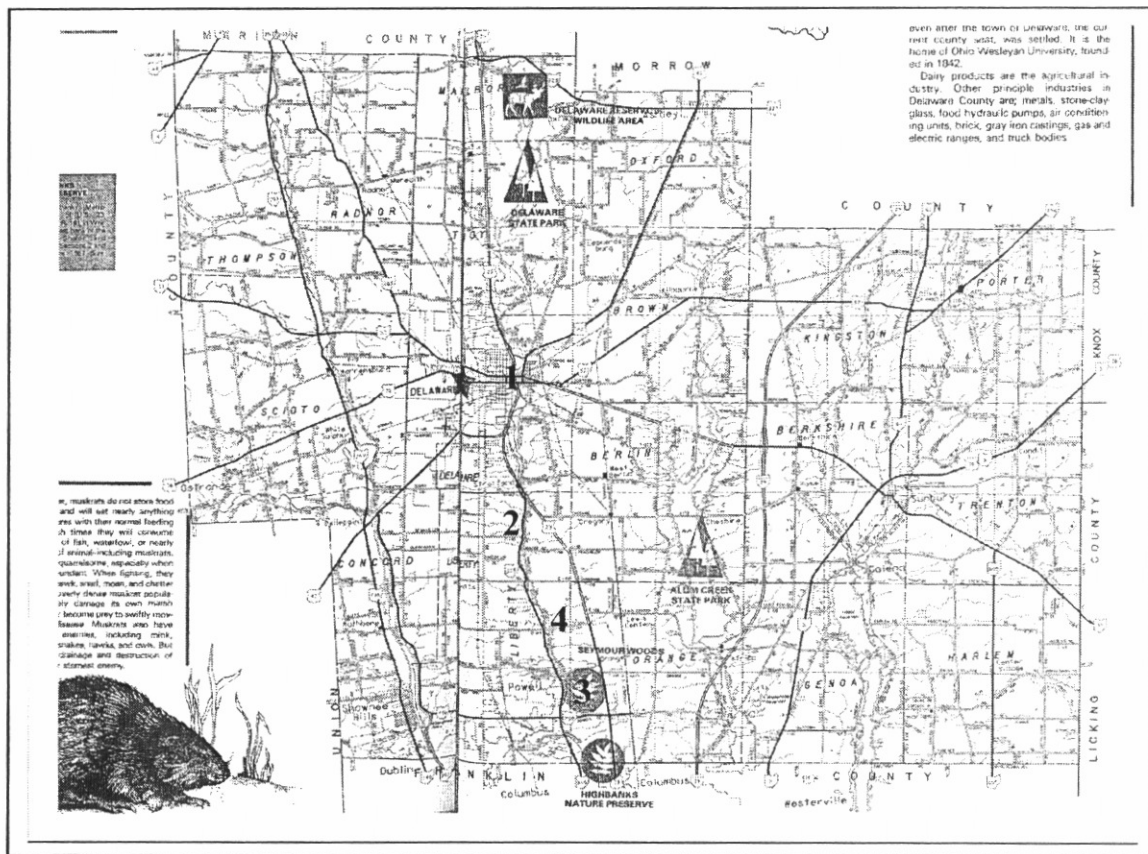


Figure 2 – Site Map of Delaware County

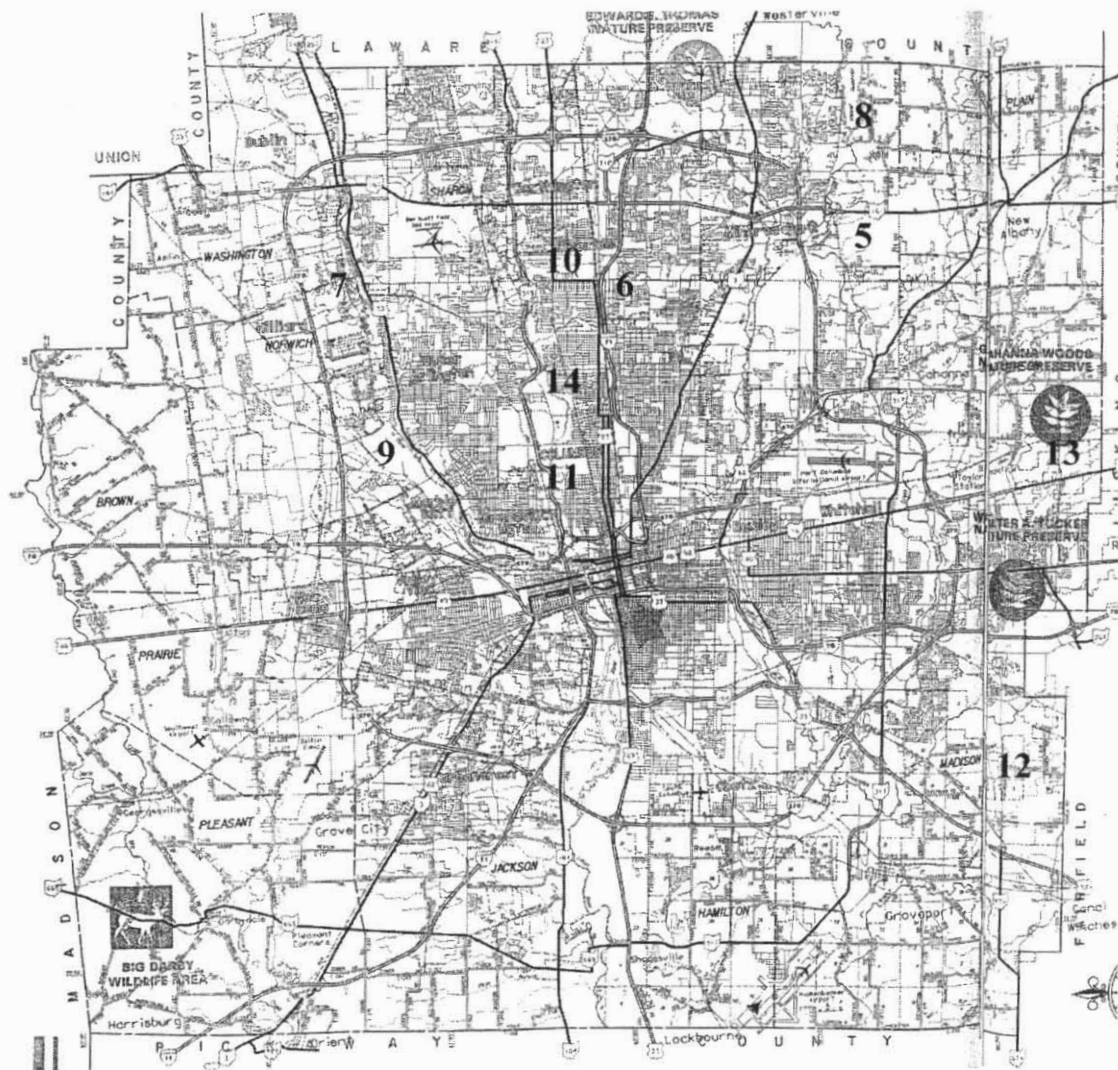


Figure 3 – Site map of Franklin County

SITE # 1

Blue Limestone Park, Delaware

Geologic Features: Delaware Limestone – visible as outcrops on the far side of the old quarry, now a pond. It is also visible as a shelf next to the parking area.

Directions: Blue Limestone Park is located in the city of Delaware. To reach the park, travel north from Columbus on U.S. Route 23, and take the exit for N. Sandusky Street/William Street. Turn left at the bottom of the ramp onto E. William Street. Continue to Elizabeth Street, turn right. Go to John Street, turn left. When John Street dead ends, turn right, then, make an immediate left into the park. The former quarry is near the back behind a baseball diamond.



Figure 4 – Road map showing location of Blue Limestone Park

Description: Delaware Limestone outcrops at this site, which is the site of a former quarry. The Delaware Limestone was quarried for use as a building stone. It contains several fossils. (See Appendix) The main part of the outcrop here is not accessible due to the quarry having filled with water. There is an outcrop of the Delaware right next to the parking area on the other side of a green wire fence.

Access and Safety: The rocks next to the parking area are accessible at any time. No prior permission is needed.

Collecting: Use of rock hammers is not permitted, but collection of samples loose on the ground is allowed.

Contact information: Delaware Parks and Recreation Office – (740) 368-1540

SITE # 2

Camp Lazarus: Boy Scouts of America Camp

Geologic Features: Columbus Limestone – outcrop (about 30 cm) near river level, can be seen in a small anticline if water is low.
 Delaware Limestone – outcrops along ravine
 Olentangy Shale – outcrops along ravine
 Ohio Shale – outcrops along ravine, is part of the lower member and shows concretions.

Directions: The main entrance of the camp is on U.S. Route 23. The Lazarus Run section that is the focus of this stop runs between Chapman Road and the main entrance to the camp. You may go from either direction when exploring the ravine. If starting from the main entrance, please park in the parking lot to the left just inside the entrance to the camp and check in before beginning. If entering from Chapman Road, you may park along the side of the road near the entrance to the ravine, after checking in with camp officials. The land east of Chapman Road belongs to the camp.

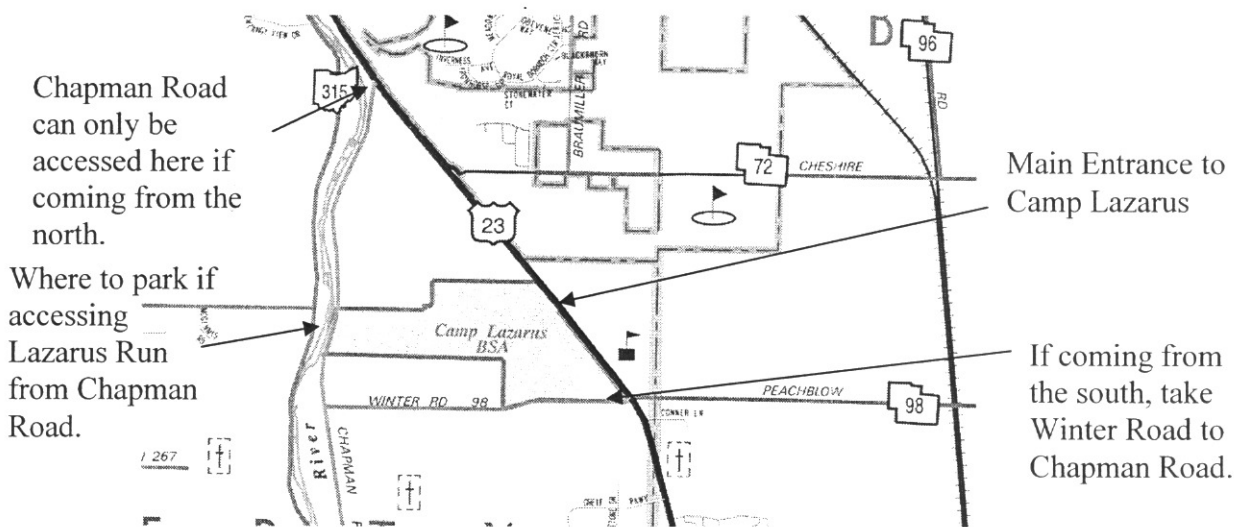


Figure 5 – Road map to Camp Lazarus

Description: Much information describing the Lazarus Run site is based on an Ohio Academy of Science field trip guide. For full information about this guidebook, please see the reference list under Krissek, 1995.

Several bedrock units are exposed at Lazarus Run. The rocks are all of Devonian age and are limestones and shales. The oldest unit visible is the Columbus Limestone. Only a small portion of this unit is visible as you make your way up the stream. Above this unit, the Delaware Limestone is present. At this site it is composed of thinly bedded limestones and shales. Fossils that may be found in this unit include corals, brachiopods, and crinoid stems. (See Appendix for examples) The fossils are most abundant in the upper

portion of the Delaware. The soft, blue-gray shale of the Olentangy Shale unit is the next youngest rock that can be seen in this area. It is easily weathered and can be seen best at or slightly above water level. Above the Olentangy Shale is the Ohio Shale. At this site, only the lower part of the Ohio Shale is visible and it contains many concretions.

Location:

This site contains many features that are visible all along the Lazarus Run section which begins at Chapman Rd and goes east along the stream through Camp Lazarus. There is a fork in the ravine as you head east from Chapman Rd. The left branch of the fork is considered a pristine gorge area since there has been no disturbance to it, while the right branch is the part of Lazarus Run that takes you back toward the main entrance to the camp. This section has been slightly disturbed by the building of small dams along the creek by the camp.

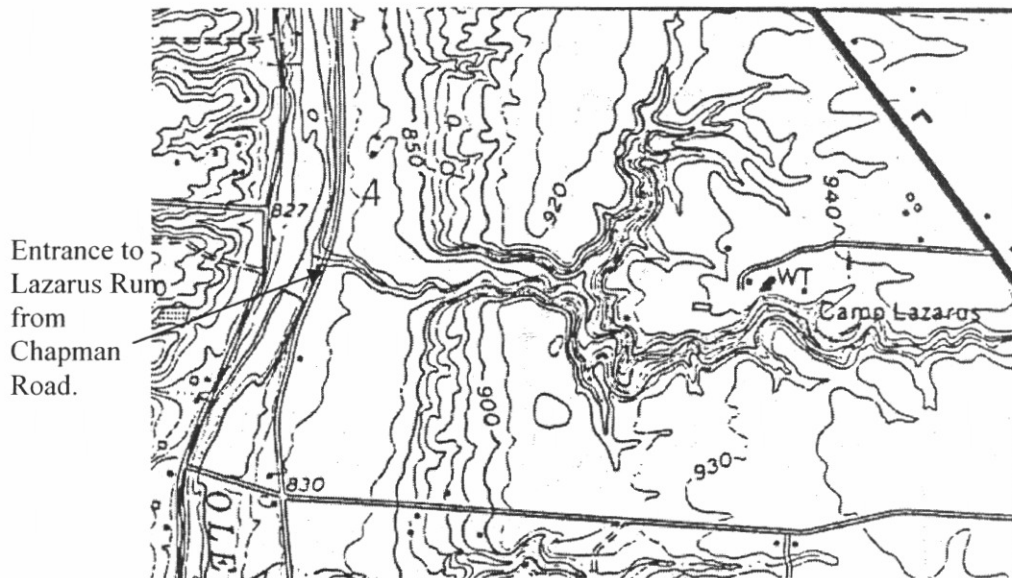


Figure 6 – Outcrop location map for Lazarus Run

Access and Safety:

Camp Lazarus is open year round. The camp must be contacted in advance to schedule a time to visit. This way the camp can verify that it will not be closed or reserved at the time of your anticipated visit.

- There are no improved paths through the ravine and any trip is made at the risk of the individual. There are no seasonal constraints as to when Lazarus Run may be visited, but again, it is at the risk of the individual if they choose to visit in bad weather.
- When planning a visit to Lazarus Run, please contact the camp several weeks in advance to insure there will be no

conflicts that will prevent you from being able to visit at the time requested.

- At the time of the visit, please check in with camp officials before beginning.

Collecting: Collection of rock and fossil specimens is, at the time of this paper allowed. Please verify that this is still the case when contacting the camp to set up a visit.

Contact information: Camp Lazarus Ranger – (740) 548-5502 – current ranger is Chuck Howard

SITE #: 3 Highbanks Metro Park

Geologic Features: 1. Ohio Shale – Cliffs and outcrops
 2. Glacial erratics along stream, especially visible at Streamside Program Area
 3. Fluvial landforms and processes

Directions: Highbanks Metro Park is located off U.S. Route 23, approximately 2 ¾ miles north of the Columbus I-270 outerbelt on the North side of Columbus.

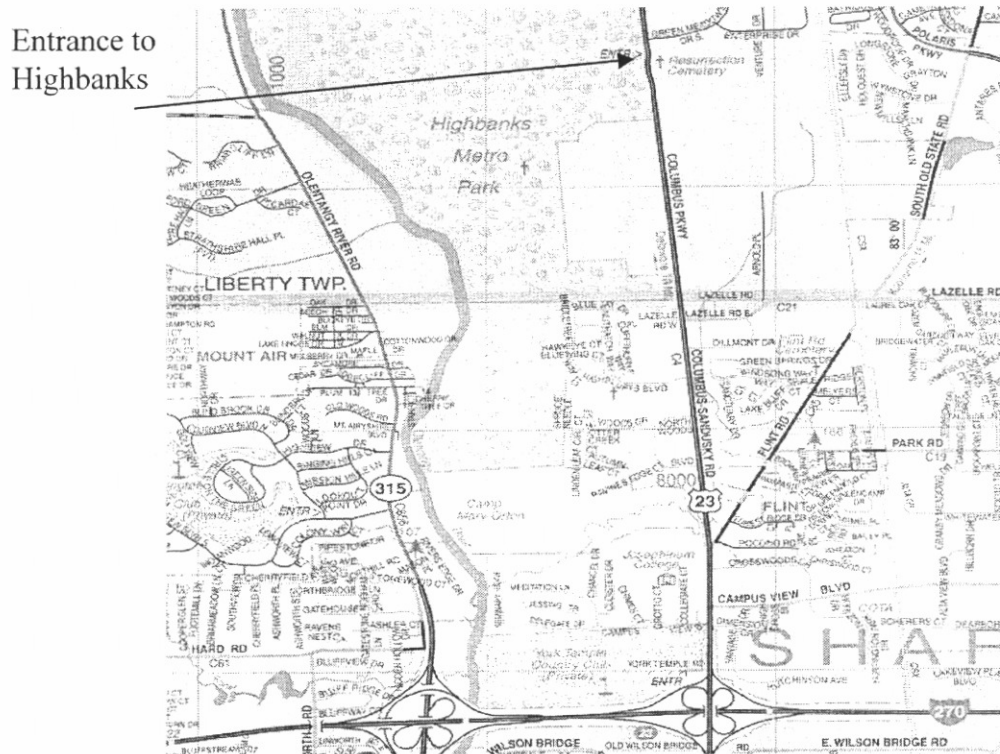
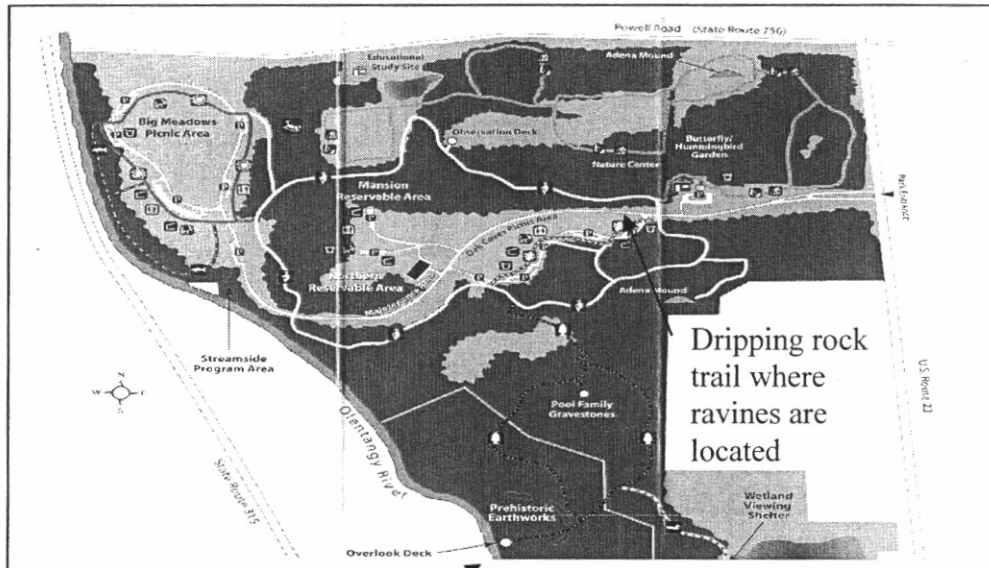


Figure 7 – Road map showing location of Highbanks Metro Park

Description: The type of rock that outcrops in the park is Ohio Shale, which is of Late Devonian age, and formed about 374 to 360 mya. The shale is a black and fissile with a high organic content. See geology and geologic history section for more information concerning the Ohio Shale.

Location: Within the park, there is an observation deck along the banks of the Olentangy River which allows you to see the 100 foot high cliffs of Ohio Shale for which the park was named. You can also see the Ohio Shale in the ravines along the Dripping Rock trail. These ravines show fluvial processes and landforms as they wind their way through the park. Group walks may be scheduled with the naturalists at the park so that visitors may see the outcropping

rocks more closely. The park also has walks that they set a time for that, are open to the public. One of these walks, The Great Ravine Adventure takes you through a ravine, starting behind the Nature Center. This walk allows you to see the Ohio Shale up close, and to see the contact between the Ohio Shale and the underlying Olentangy Shale. For more information about group walks, please see the Access and Safety portion of this site.



Overlook deck where you
can see the shale cliffs

Figure 8 – Map of Highbanks Metro Park showing locations of outcrops.

Most information about the park was obtained from the Naturalists working in the Nature Center within the park.

- Access and Safety: Highbanks Metro Park is open everyday.
- Visitors must stay on nature trails unless accompanied by a park employee.
 - To set up group walks with a naturalist so that you may get closer to the outcropping rocks, contact either the Metro Parks district office or the Highbanks Nature Center several weeks in advance. Groups must have at least 15 people.
 - The streamside program area is not accessible during time of high water in the river.
- Collecting: Rock hammers are not permitted and no collection of rocks or fossils is allowed.
- Contact information: Metroparks District office: (614) 891-0700, www.metroparks.net
Highbanks Nature Center: (614) 865-4507

SITE # 4

Olentangy Indian Caverns

Geologic Features: Underground Caverns -- cut through Columbus Limestone and Delaware Limestone, formed millions of years ago by an underground river.

Directions: The Olentangy Indian Caverns are located on Home Road, west of U.S. Route 23, north of Columbus, south of Delaware. There are signs along the highway directing you to the site.



Figure 9 – Road map showing location of the Olentangy Indian Caverns

Description:

The Olentangy Indian Caverns were formed millions of years ago as an underground river cut through the Columbus and Delaware limestones that form the foundation of the area. Both the Columbus Limestone and the Delaware Limestone are Devonian in age. There are many passages and rooms underground where you can see the effects the river had on the rocks it moved through them. Stalactites and stalagmites can be seen as well as deposits on the walls formed by particles coming out of solution after the caves formed. There are three levels currently open to the public. The third level reaches a depth of 105 feet underground. A fourth level, which contains an underground river and lake, is not yet open to the public at the time of publication. Not all the passages that make up the cave system are open to the public. There are many more passages that run off the main ones that are seen in the tour. Many of these are in the process of being explored, some of which may become open to the public at some time in the future.

In addition to the cave tours, there are many other activities for the entire family. They include an Indian museum and an Indian goods store. There is also a petting zoo, a climbing wall, a playground with volleyball court and horseshoe playing fields.

- Access and Safety: Caverns are a constant temperature of about 54 degrees Fahrenheit.
Dress appropriately.
The Caverns are open everyday from April 1 to October 31, 9:30 AM till 5:30 PM.
There is a charge for admission into the caverns.
The caverns are not wheelchair or stroller accessible.
- Collecting: No collection of specimens is permitted from inside the caverns.
- Contact information: Call 740-548-7917 in season or e-mail at ouc@olentangyindiancaverns.com for more information regarding rates, payment options, tours, and other attractions at the site.

SITE # 5

Blendon Woods Metro Park

Geologic Features:

1. Bedford Shale – outcrops along creek
2. Berea Sandstone – outcrops along creek
3. Fluvial landforms and processes

Directions:

Blendon Woods is located off of Old State Route 161 on the Northeast side of Columbus. Take 270 towards the Northeast corner of Columbus. Take the exit for 161 east. Go to the exit for Little Turtle Way and turn right at the top of the ramp. Make an immediate right onto Old State Route 161 (East Dublin-Granville Road). The entrance to the park is on the left.

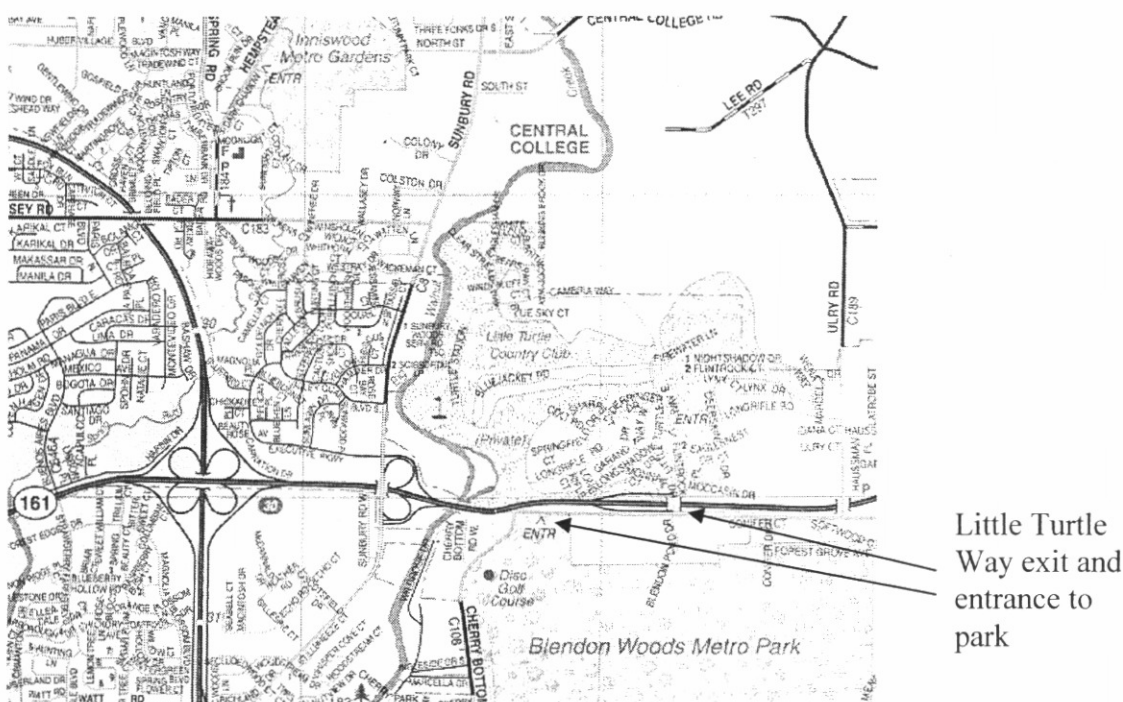


Figure 10 – Road map showing location of Blendon Woods Metro Park

Description:

Outcrops of Bedford Shale and Berea Sandstone are both visible in the park near the nature trails. Both units are Late Devonian in age which means they formed about 374 to 360 mya. The Bedford is a chocolate brown color on a fresh surface and weathers to a reddish brown color. The Berea Sandstone is a light tan or gray color and shows excellent ripple marks.

Location:

The Bedford Shale can be seen along the Brookside Trail. The best place to see it is about halfway through the 0.75 mile trail (see map). The outcrops there are about 10-20 feet high and show the disturbed nature of this part of the unit. The Berea Sandstone can be seen along the 0.4 mile Ripple Rock Trail. There is a sign along

the trail and several pieces of the Berea Sandstone which show some of the excellently preserved ripple marks in this unit. Both of these rock units can be seen up close on a creek walk with a Naturalist from the Nature Center at the park. Please see the Access and Safety section for more information about scheduling walks with the Nature Center.

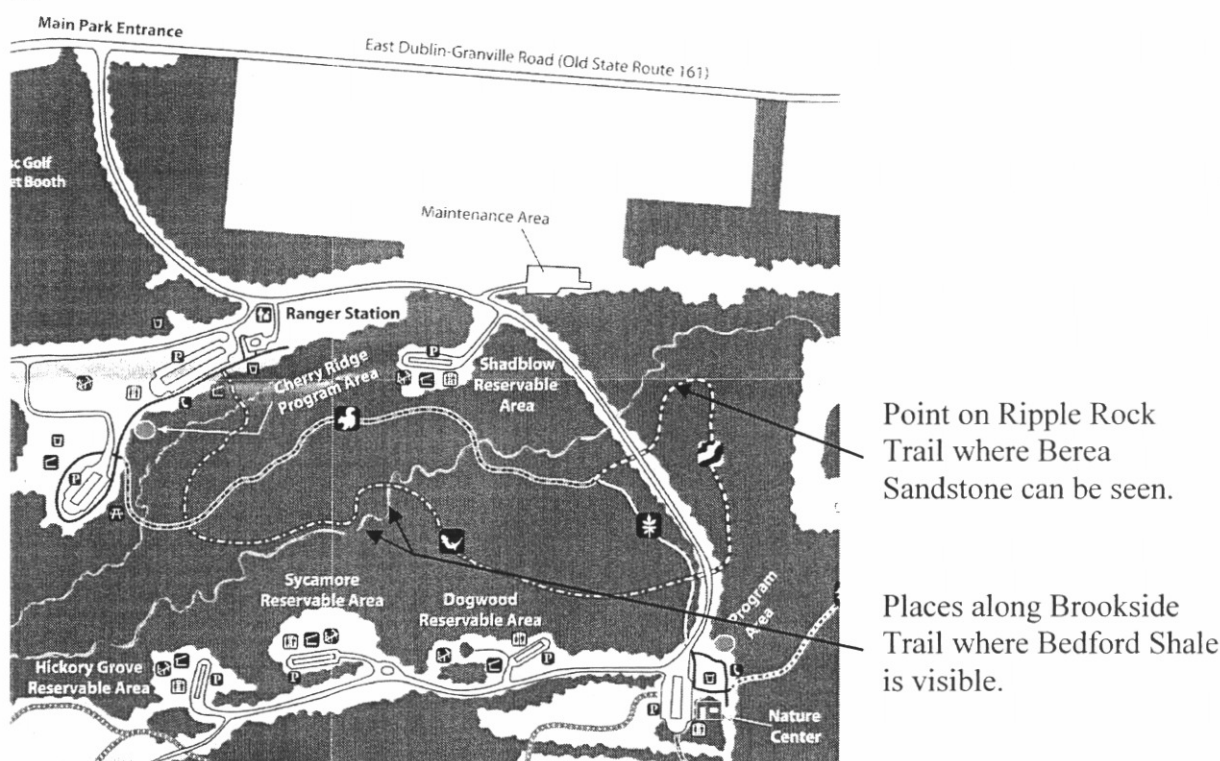


Figure 11 – Map of Blendon Woods Metro Park showing outcrop locations

Access and Safety: Blendon Woods Metro Park is open everyday

- Visitors must stay on marked nature trails unless accompanied by a park employee.
- To set up group walks with a naturalist so that you may get closer to the outcropping rocks, contact either the Metro Parks district office or the Blendon Woods Nature Center several weeks in advance. Groups must contain at least 5, but no more than 15 people.

Collecting: Rock hammers are not permitted and no collection of rocks or fossils is allowed.

Contact information: Metroparks District office: (614) 891-0700, www.metroparks.net
Blendon Woods Nature Center: (614) 895-6221

SITE # 6

Fountain Square – Earth Day Monument

Geologic Features: A monument consisting almost entirely of Ohio building stones.

Directions: Fountain Square is located just south of Morse Road, between Karl Road and Cleveland Avenue. The entrance is just east of the former Northland Mall. Turn south onto Heaton Road and make an immediate left onto the service road. Turn right onto Fountain Square Drive. Follow this road to the main parking lot which will be on the right.

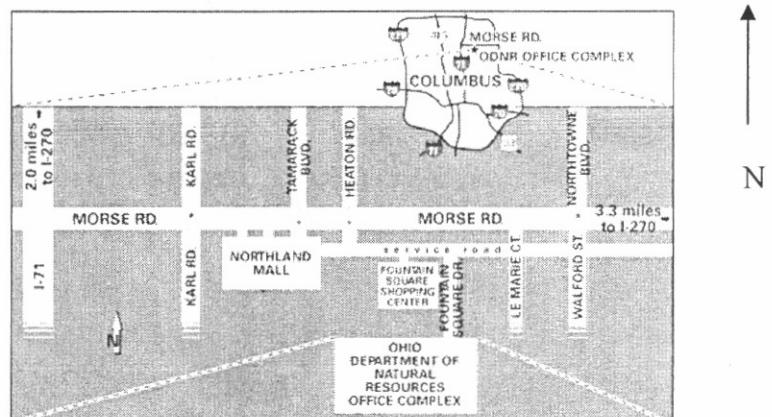
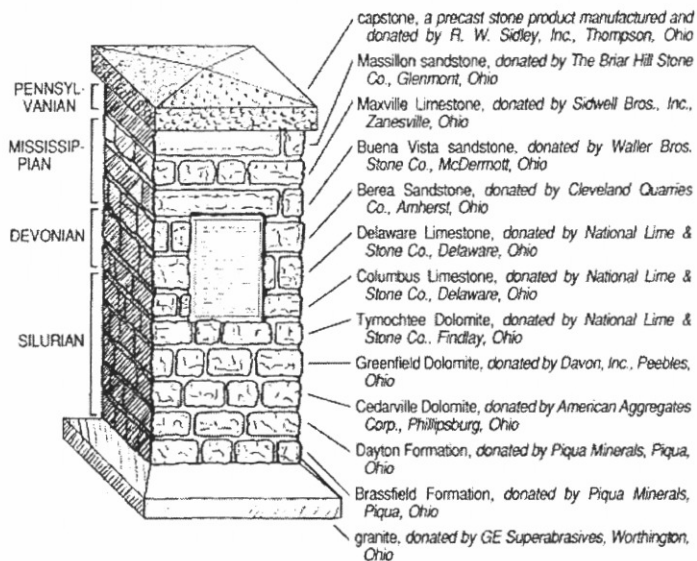


Figure 12 – Road map showing location of Fountain Square (from Ohio Department of Natural Resources website, <http://www.ohiodnr.com/geosurvey/aboutus/location.htm>)

Description: Information about the Earth Day Monument at Fountain Square comes from Melvin and McKenzie, 1992, p. 26 (see reference list). The monument “was built with donations, including material, time, and labor, from the mining and construction industries and the geological and educational communities of Ohio.” It contains a time capsule that commemorates the 20th anniversary of the first Earth Day.

“The granite at the base of the monument represents Precambrian rocks (>570 million years old) that underlie Ohio at great depths. The Ohio stones are arranged in ascending stratigraphic order and range in age from Silurian (438 to 408 million years before present) to Pennsylvanian (320 to 286 years before present). A precast stone cap represents the Quaternary Period.” (Melvin and McKenzie, 1992, p. 26)

All of the building stones are sedimentary in nature. They consist of sandstones, limestones, and dolomites. These stones were chosen for use as building stones because of their durability. Shales are not used as building stones because they are usually soft and weather easily.



Monument sponsors and contributors: Anderson Concrete Corp.; Ben Cookson, Inc.; Columbus Stone Center, Inc.; Complete Resources Co.; Gaddis & Son, Inc.; George J. Igal & Co., Inc.; The Northern Ohio Geological Society; Ohio Aggregates Association; The Ohio Contractors Association; Ohio Department of Natural Resources; Ohio Department of Transportation; The Ohio Geological Society; Ohio Manufacturers Association; Ohio Mining and Reclamation Association; The Ohio State University; Dr. Paul E. Potter.

Figure 13 – Sketch showing ages and types of building stones used in the monument.
(from Melvin and Mckenzie, 1992, p.26)

- Location:** The monument is located on the lawn to the east of the main parking lot, near the pond.
- Access and Safety:** The monument is currently accessible anytime. Construction is currently underway for a new guard house. This will not likely, but may possibly, affect accessibility to the monument.

SITE # 7

Hayden Run Falls Park, Columbus

Geologic Features:

1. Columbus Limestone – in outcrops
2. Delaware Limestone – in outcrops
3. A 30 foot waterfall caused by water flowing over resistant rocks

Directions: Hayden Run Falls is a city park, part of the City of Columbus Recreation and Parks. It is located in the northwest portion of the city, near Dublin. To reach the park, take the I-270 outerbelt to the northwest side of Columbus and exit at Tuttle Crossing Boulevard. Go west. Turn right (south) onto Frantz Road. Take Frantz Road to Hayden Road and turn left. There is a parking area just off the right side of the road, right before the bridge going over the river.

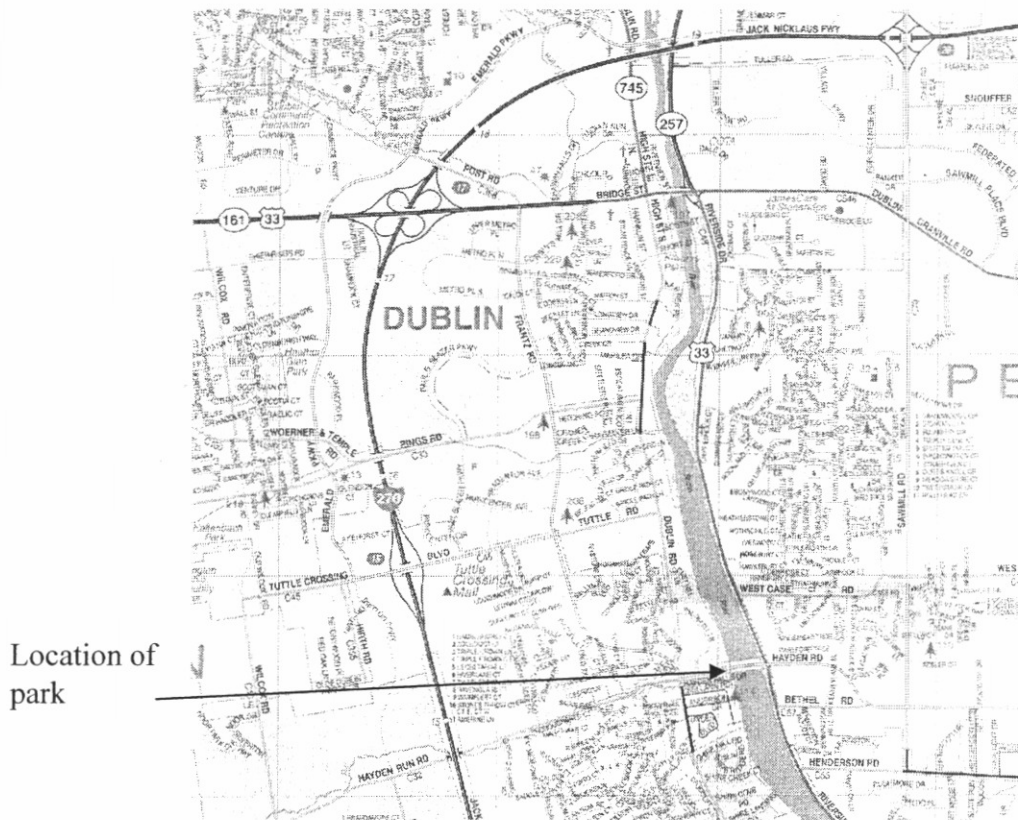


Figure 14 – Road map showing location of Hayden Run Falls Park

Description: Columbus and Delaware Limestones show in outcrops along the sides of the ravine, and at the site of a 30 foot high waterfall. Both units are Devonian in age and contain many fossils. The Columbus Limestone is a pale gray color, while the Delaware has a slightly bluish color. Pieces of both units as well as glacial erratics can be seen on the floor of the ravine.

- Location: After parking, walk down towards the river and go around the fence there. Head back along the ravine area until you reach the water fall. Keep an eye out for fossils in pieces of rock that are on the ground.
- Access and Safety: Paths into the area are sometimes steep and made of mud, which causes them to be very slippery when wet.
- Collecting: Specimens may be collected that are already loose. Use of rock hammers to collect fossils is prohibited.
- Contact information: Columbus Recreation and Parks – Elayna Grody – (614) 645-3304

SITE # 8

Hoover Dam – Near Disc Golf Course

- Geologic Features:
1. Bedford Shale – outcropping along cut banks of creek inside of a ravine
 2. Fluvial processes

Directions: Hoover Dam is located on the Northeast side of Columbus. Take 270 to State Route 161, head east, then, take the Sunbury Road exit. Go north on Sunbury Road to Central College Road and turn right. The entrance to this site is on the left.

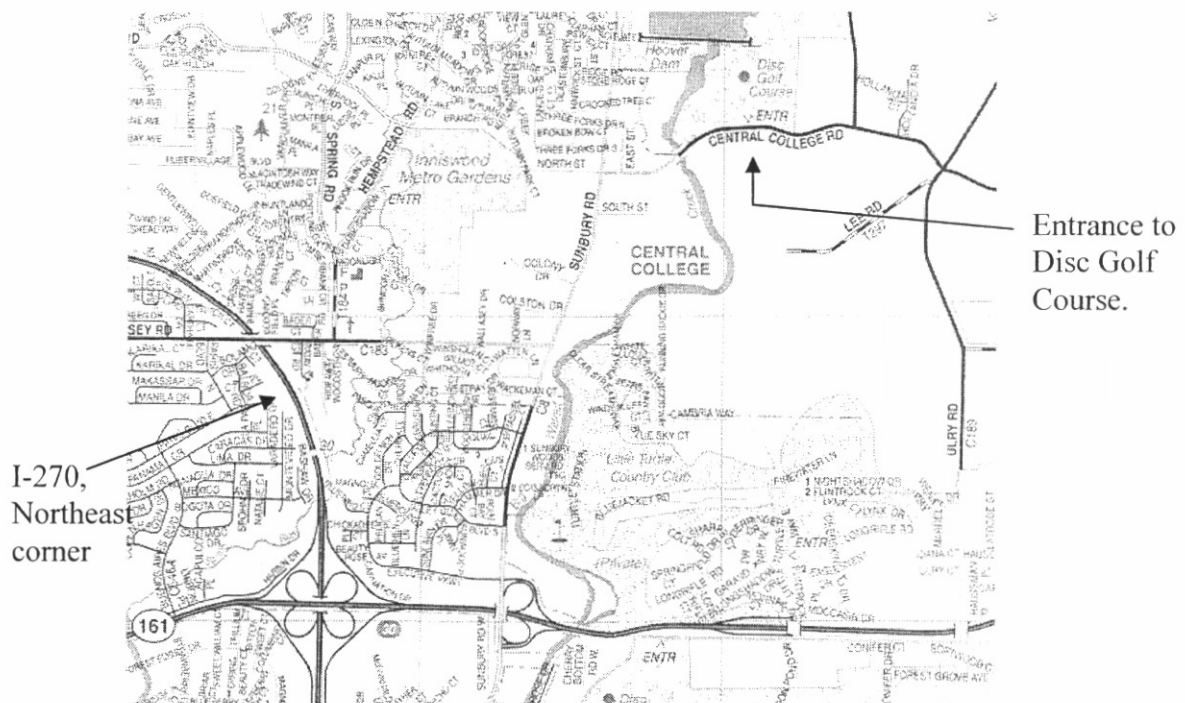


Figure 15 – Road map showing location of Hoover Dam Disc Golf Course

Description: This location shows outcrops of the Bedford Shale, which is Late Devonian in age and formed about 374 to 360 mya. The Bedford here is a chocolate brown color on a fresh surface and weathers to a reddish brown. It is very soft and can easily be broken by hand.

Location: Once inside the park entrance, take the first road to the right (at the stop sign). Park in the parking lot on the left side of the road just past the dam. There is ravine located in the wooded area across the road from the lower playing field of the disc golf course. There are disc golf holes located within this wooded area. The ravine is next to hole # 14. The easiest place to enter the ravine is about half way through hole 14. (see map) A short distance into the ravine, there is a small creek. Along the creek there are cut banks several feet high that show the Bedford Shale.

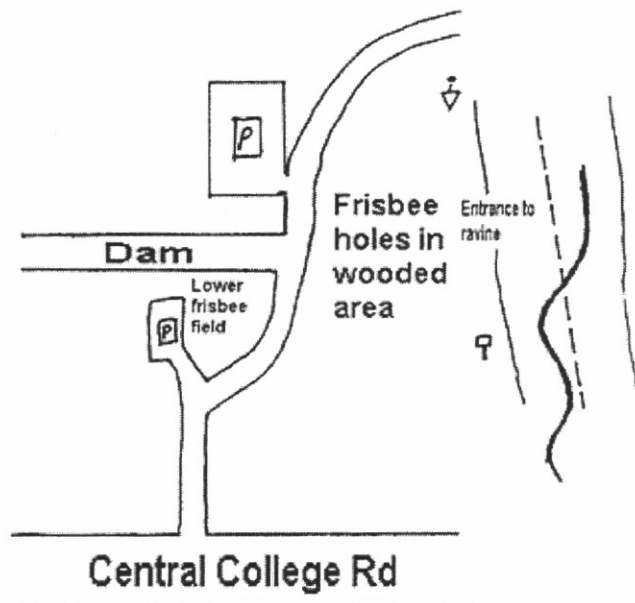


Figure 16 – Sketch showing directions to the site once inside of Hoover Park

- Access and Safety: The path into the ravine is made of mud and can be slippery if it is wet. There is not much of a path beside the creek and the bed of the creek may need to be followed for part of the time. Also, the creek must be crossed when you first come to it. This may be difficult to do if there has been a lot of rain and the water is high.
- Collecting: Use of rock hammers is not permitted and collection of samples is not allowed.

SITE # 9

Marble Cliff Quarry

Geologic Features: 1. Salina Group – visible as a result of quarrying operations
2. Columbus Limestone – upper - Delhi Member, and lower - Bellepoint Member – both visible as a result of quarrying operations

Directions: Marble Cliff Quarry is located on the West side of Columbus, on Dublin Road where Roberts Road dead ends. To get there, take I-270 to the West side of Columbus, take the Roberts Road exit and head east, towards Columbus. When Roberts Road dead ends into Dublin Road, go straight at the traffic light into the entrance of the quarry. The office is about ½ mile down the road, on the right.

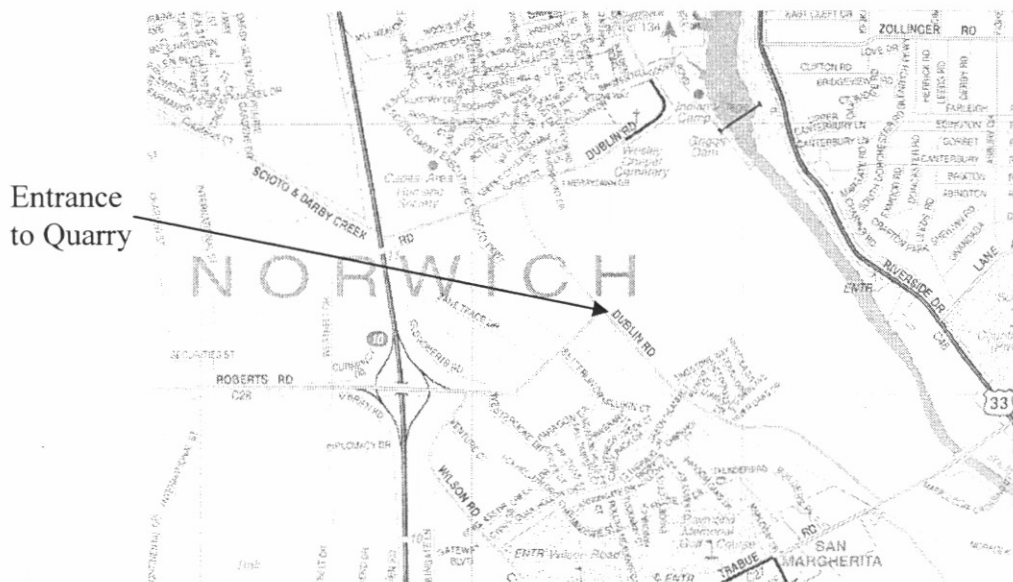


Figure 17 – Road map showing location of Marble Cliff Quarry

Description: The Columbus Limestone, both the Delhi and Bellepoint Members, are visible at this site. This is the oldest of the Devonian age rocks visible in Central Ohio. The Delhi is the upper member of the Columbus, and is very pure at this location. It is white in color and contains many fossils. Of the units outcropping here, it is the unit that has been quarried the most. The Bellepoint member, which is browner in color, has also been quarried, although not as extensively. The outcrops show fractures most likely caused by release of pressure after the thick ice sheets from the last ice age disappeared.

This site also allows you to see outcrops of the Salina Group, which is late Silurian in age. This unit is normally only visible near the western edge of Franklin and Delaware Counties. Only a maximum of a few feet of the unit would normally be visible in the

selected study area. At this site, however, over a hundred feet of the unit is currently visible as it is being quarried down so that a tunnel can be built to quarry it from underneath the current quarry floor.

Access and Safety: Marble Cliff Quarry may only be accessed with permission on a tour with a representative of the company.
Please contact the quarry representative several weeks in advance to schedule a tour of the facility.

Collecting: Rocks may be picked up from the quarry floor with permission of the representative who is giving the tour of the site.

Contact information: Garry Getz, Geologist, Shelly Materials, Inc., Aggregate Division
– (614) 437-2335

SITE # 10

Ohio State School for the Deaf

Geologic Features: 1. Glacial till – shown in outcrops along creek. Outcrop faces show up to 40 feet or more.
2. Fluvial processes – shown in creek flowing through ravine.

Directions: The School for the Deaf is located on Morse Road just east of N. High Street. Take either N. High Street, or I-71, to Morse Road. If coming from High Street, turn east onto Morse Road, the school entrance will be on the left. If coming from I-71 from the north, take the Morse Road/Sinclair Road exit. At the bottom of the ramp, turn left, then turn right at the next light (Morse Road). The school entrance will be on your right. If coming from I-71 from the south, exit at Morse Road and turn left at the bottom of the ramp. The school entrance will be on the right. The administration office is next to the last parking area. When entering the school grounds, take the road to the right when it branches. The Administration Office is by the last parking area, on the left side.

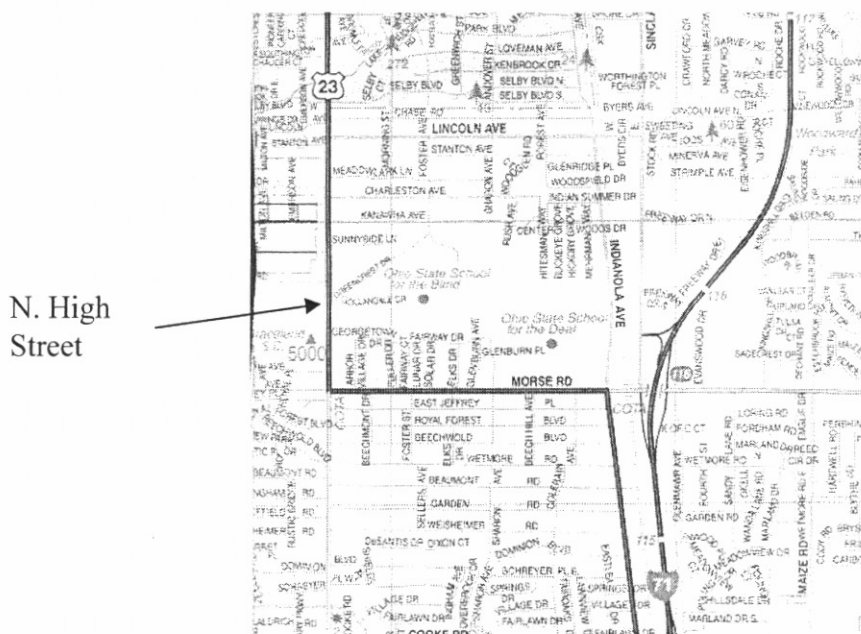


Figure 18 – Road map showing location of School for the Deaf

Description: Glacial till deposits were left here by the most recent glacial period, the Wisconsinian, which ended about 14,000 years ago. Till is composed of unsorted boulders, dirt, and rock fragments deposited directly by ice. The deposits at this site are composed mainly of mud with fragments of other rock types ranging in size from several millimeters up to several inches across. To learn

more about the till deposits in the area, please see the introduction and the Appendix. The bed of the creek that runs through the ravine has many glacial erratics ranging in size up to several feet across.

Location: Till outcrops can be seen along the back of the school property, through a wooded area, along a creek. The contact at the school can show you a topographic map and point out places that might be good to see the outcrops. When following the fence marking the property line down to the creek, some of the best outcrops can be seen if you follow the creek to the left (west).

Access and Safety: A time must be set several weeks in advance before visiting this site. Before beginning a trip into the ravine area, you must check in at the Administration Office with the representative at the school. He will be able to show you the best way to get into the ravine. There is no distinct path through the brush. Poison ivy and mosquitoes are abundant. It is advisable to wear long pants, long-sleeved shirt, and bug spray. A visit to this site must be made at your own risk.

Collecting: At this time, use of rock hammers and collection of samples is permitted.

Contact information: David Wojnowski – (614) 728-4030

SITE # 11

Orton Hall – Ohio State Campus

- Geologic Features:
1. Examples of 40 different Ohio building stones – seen in the entrance hall, walls and foundations of the building.
 2. Carvings and gargoyle-like figures representing fossil animals as well as the races of Man.
 3. The Orton Geological Museum – shows minerals and fossils native to Ohio, as well as a geologic history of Ohio.
 4. The Orton Geological Library – one of the finest geological libraries in the country

Directions: Orton Hall is located on the oval of Ohio State's campus. It can be reached by taking N. High Street to W. 12th Avenue. Turn west, then, turn right onto College Road. Make a left onto Hagerty Drive which runs behind Orton Hall. There are several parking meters along Hagerty Drive at which you may park. There are also many other parking meters and parking garages throughout the campus area.

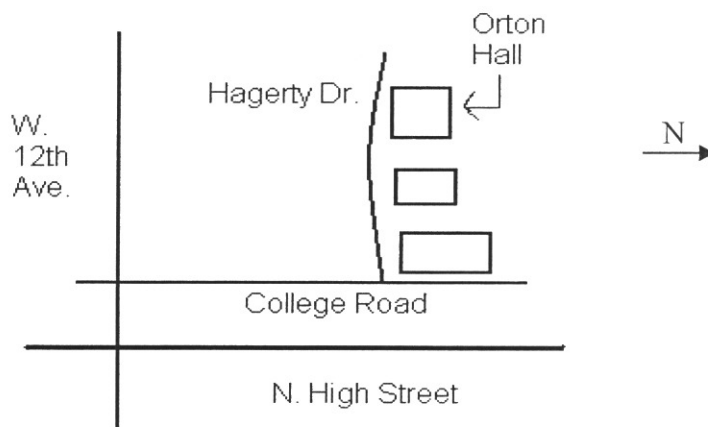


Figure 19 – Location of Orton Hall

Description: Information about Orton Hall provided from a brochure printed by the Orton Geological Museum, as well as from the Geological Sciences website (<http://www.geology.ohio-state.edu>), under the facilities link. The stones that were used to build Orton Hall are mostly Ohio building stones. There are 40 different examples of these stones which can be seen in places from the tiles of the entrance way, to the walls and foundations of the building. In the outside walls, the stones are in stratigraphic order according to their relative positions in Ohio's bedrock. The lower basement levels are built from Springfield Dolomite and Dayton Limestone which are both Silurian in age, about 420 million years old. Parts of the main and second floors and the bell tower, including trim

around doors and windows, are made from the Berea Sandstone. Having formed only about 350 million years ago, it is one of the youngest rocks used in the building of Orton Hall. Carvings of fossils and large pillars, that are made of Ohio's building stones, can be seen in the entrance way. Orton Hall is also home to the Orton Geological Museum. In the Museum you can see exhibits showing the fundamental concepts about minerals and their physical properties. There are several exhibits devoted to fossils. Fossils are important because they document the evolution and development of life through time, they help indicate the age of the rocks in which they occur, and they also provide information about the environments that existed in the past. The Orton Geological Library is also contained in this building. It is one of the finest geological libraries in the country and contains over 150,000 books and maps.

- Access: Orton Hall is open during normal school hours. There is no entrance fee to visit the Museum, and tours are available on request. Museum hours are 9 A.M. to 5 P.M., but special arrangements can be made to have the Museum open at other hours. The library has varying hours. Please call ahead to ensure the library will be open if planning to visit it.
- Contact information: For more information about the Museum, or to schedule a talk or tour, call (614) 292-6896. For information regarding the library, the phone number is (614) 292-2428.

SITE # 12

Pickerington Ponds Metro Park

Geologic Features: A kettle lake – formed from the last glaciation of Ohio

Directions: Pickerington Ponds is located on the Southeast side of Columbus. To get there, take I-270 to Route 33 in the Southeast corner of Columbus, and exit east, towards Lancaster. Follow this road about 3 miles, then turn left onto Gender Road. Go about 1 mile and turn right onto Wright Road. Go about 1 mile to Bowen Road. There are two places from which you can see the kettle lake, called Ellis Pond. One observation area is on Wright Road, after crossing Bowen Road, the other is on Bowen Road. To get to it, turn right onto Bowen Road from Wright Road. The observation area will be on the left side (see map).

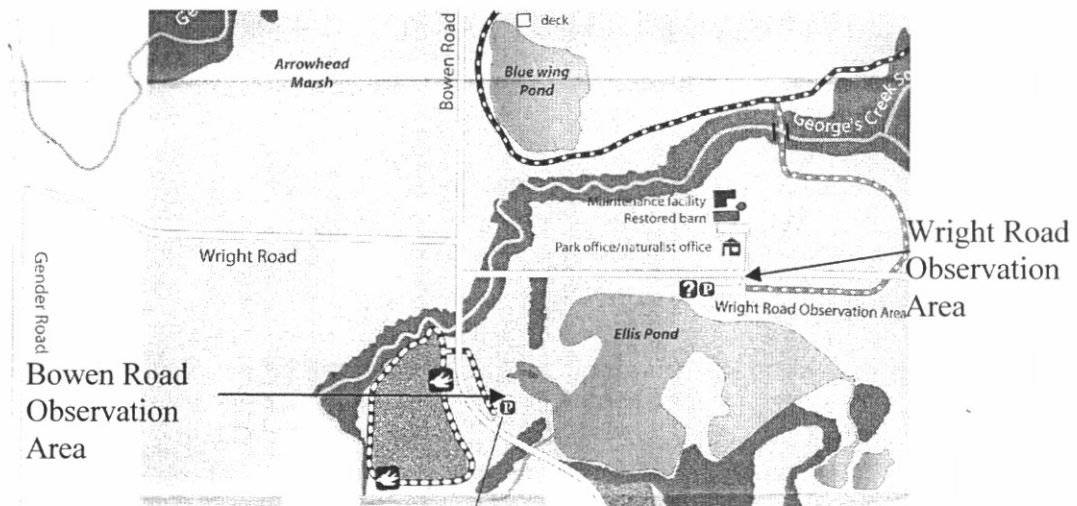


Figure 20 – Locations of observation areas in Pickerington Ponds Metro Park

Description: Ellis pond is a glacial kettle lake that formed when large chunks of ice broke free from a glacier, became imbedded in the ground, and later melted. This kettle lake formed during the last glaciation, the Wisconsinian, which ended about 14,000 years ago.

Access and Safety: Pickerington Ponds Metro Park is open everyday.

Contact information: Metroparks District office: (614) 891-0700, www.metroparks.net

SITE # 13

Pine Quarry Park, Reynoldsberg

Geologic Features: Buena Vista Sandstone, a member of the Cuyahoga formation – visible in outcrops along the edges of an old quarry

Directions: The entrance to Pine Quarry Park is located off of Kingsley Drive in Reynoldsberg. To get there, take I-270 to the East side of Columbus, and exit east onto U.S. Route 40. Turn left onto Waggoner Road. and go north to Priestly Drive. Turn right onto Priestly Drive, and follow it to Dickens Drive, turn right. Turn right onto Kingsley Drive, which will dead end into the parking lot for the park.

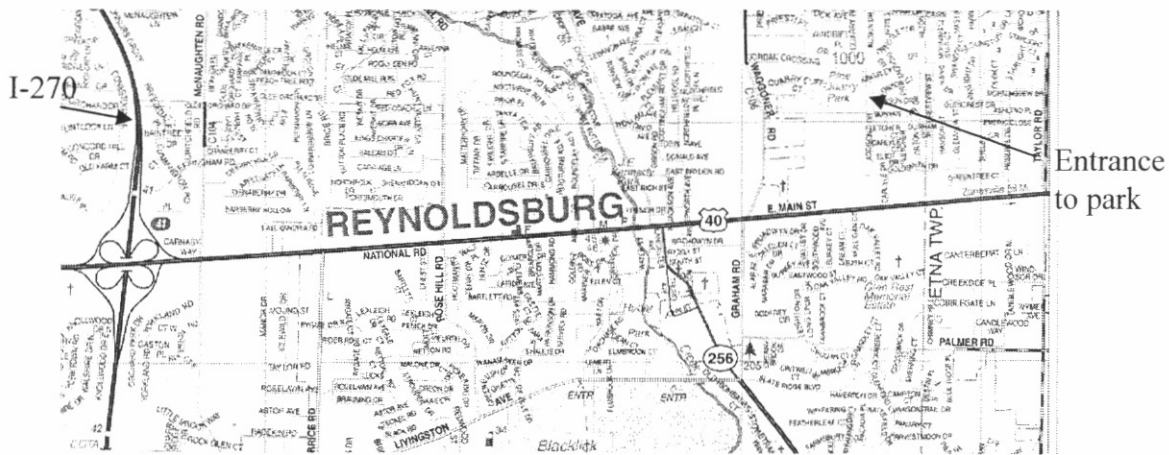


Figure 21 – Road map showing location of Pine Quarry Park

Description: The Buena Vista Member of the Cuyahoga Formation consists of “interbedded fine-grained sandstone and/or siltstone with thin gray shale layers” (Willis, 1996), and is Lower Mississippian in age. It contains several trace and body fossils.

Location: The former quarry is to the left as you leave the parking area. It is best to take the secondary path from the parking area if heading directly to the old quarry since the main path dead ends into the creek in this direction. When taking the secondary path, go to the flight of stairs down and then cross the bridge. The former quarry is just ahead.

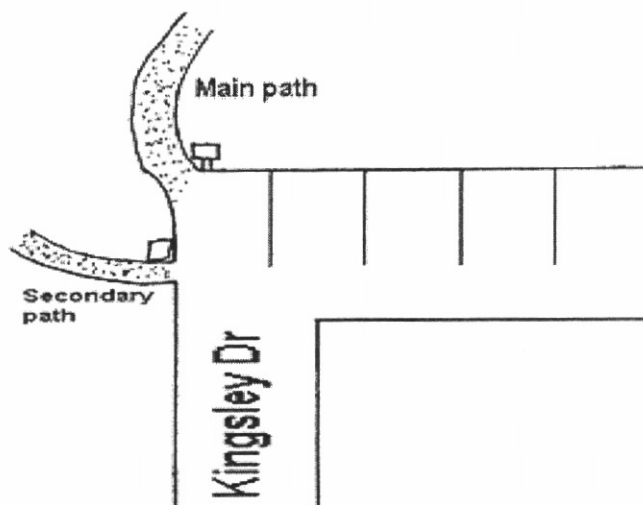


Figure 22 – Location of the secondary path in Pine Quarry Park

Access and Safety: There are many paths that go through the park. They are all made of mud and can be very slippery when wet. The paths appear to have been made by visitors to the park and are not arranged in an organized fashion. It may be easy to become disoriented and have trouble finding the correct way back to the parking area, especially near dark. The park is fairly small though so it should not be a great problem, but just something to keep in mind when visiting.

Collecting: As this is a city park, rock hammers are not permitted and no collection of rocks or fossils is allowed.

SITE # 14

Walhalla Ravine

Geologic Features: Ohio Shale – outcrops along ravine, possibly some Olentangy Shale outcropping too

Directions: Walhalla Road runs between Indianola Avenue. and N. High Street. It starts on Indianola, just south of E. North Broadway, and ends in a one way portion of road at N. High Street. The road though the ravine is narrow and winding. To be able to study the rocks, you will need to park on either Indianola Avenue, or on N. High Street, and go into the ravine on foot.



Entrance to Walhalla Ravine when driving, other end is a one way street.

Figure 23 – Road map showing location of Walhalla Road

Description: The ravine shows outcrops of Ohio Shale and possibly outcrops of the Olentangy Shale and the contact between the two units. These units are both Devonian in age (410 to 360 mya). The Ohio Shale is a black, organic-rich, fissile shale. The underlying Olentangy Shale is a soft, clay-rich shale that is a light bluish-gray color.

Access and Safety: The main danger when visiting this site is traffic on this narrow, winding road. The speed limit is low and there are signs warning drivers of pedestrians using the roadway, but there is still a danger from passing cars.

Collecting: Collection of samples is not permitted.

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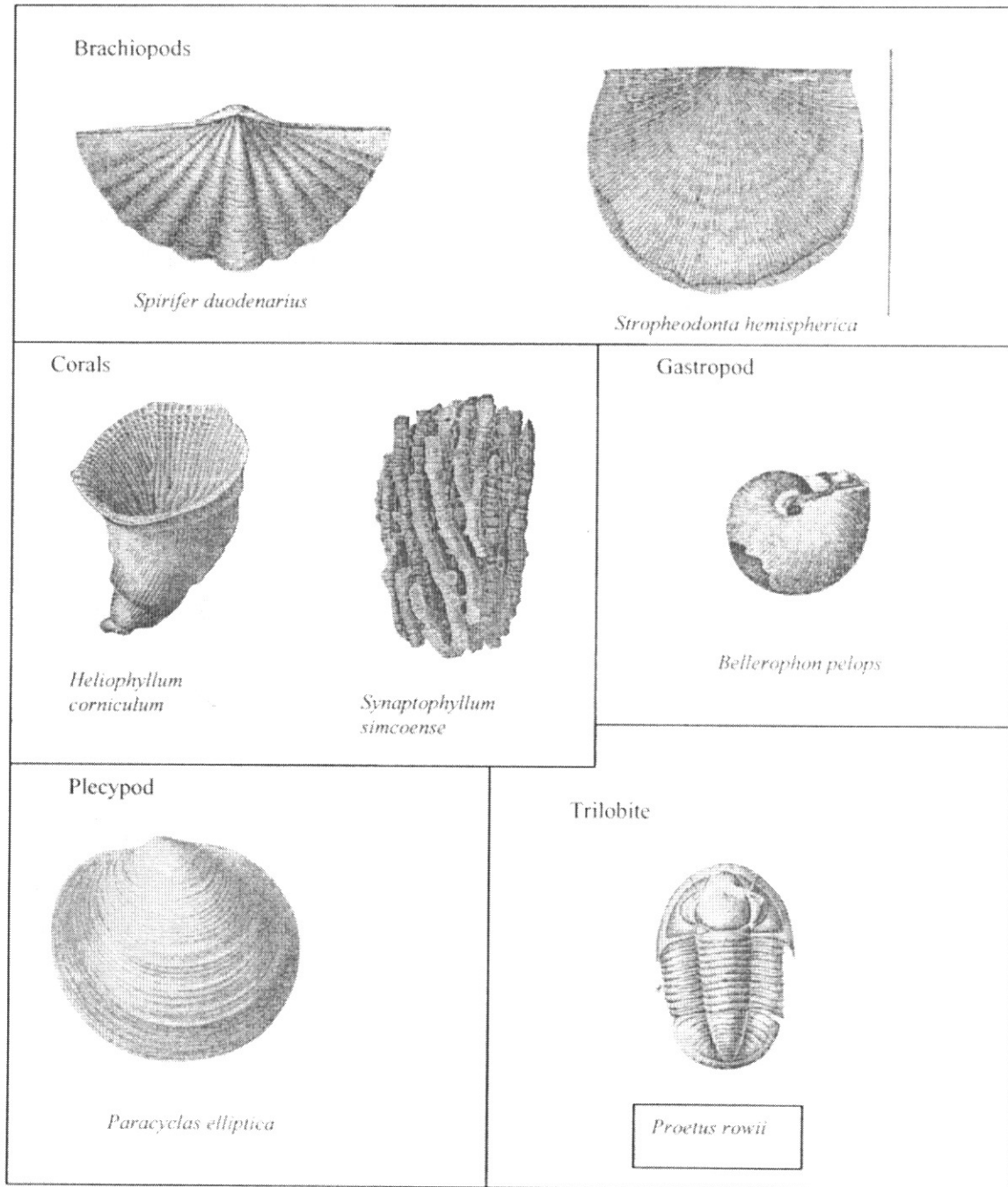
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Appendix

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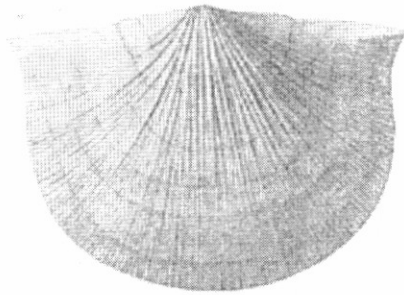
Columbus Limestone Fossils



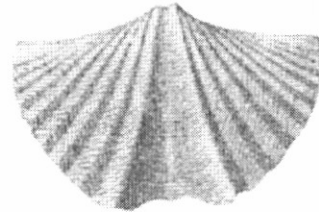
Examples of some fossils that can be found in the Columbus Limestone. Figures taken from Stauffer, 1911.

Delaware Limestone Fossils

Brachiopods

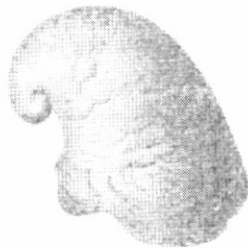


Stropheodonta demissa

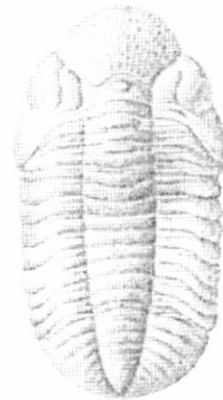


Delthyris consobrina

Gastropod

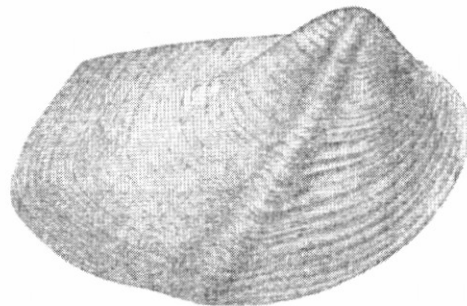


Platyceras erectum



Phacops rana

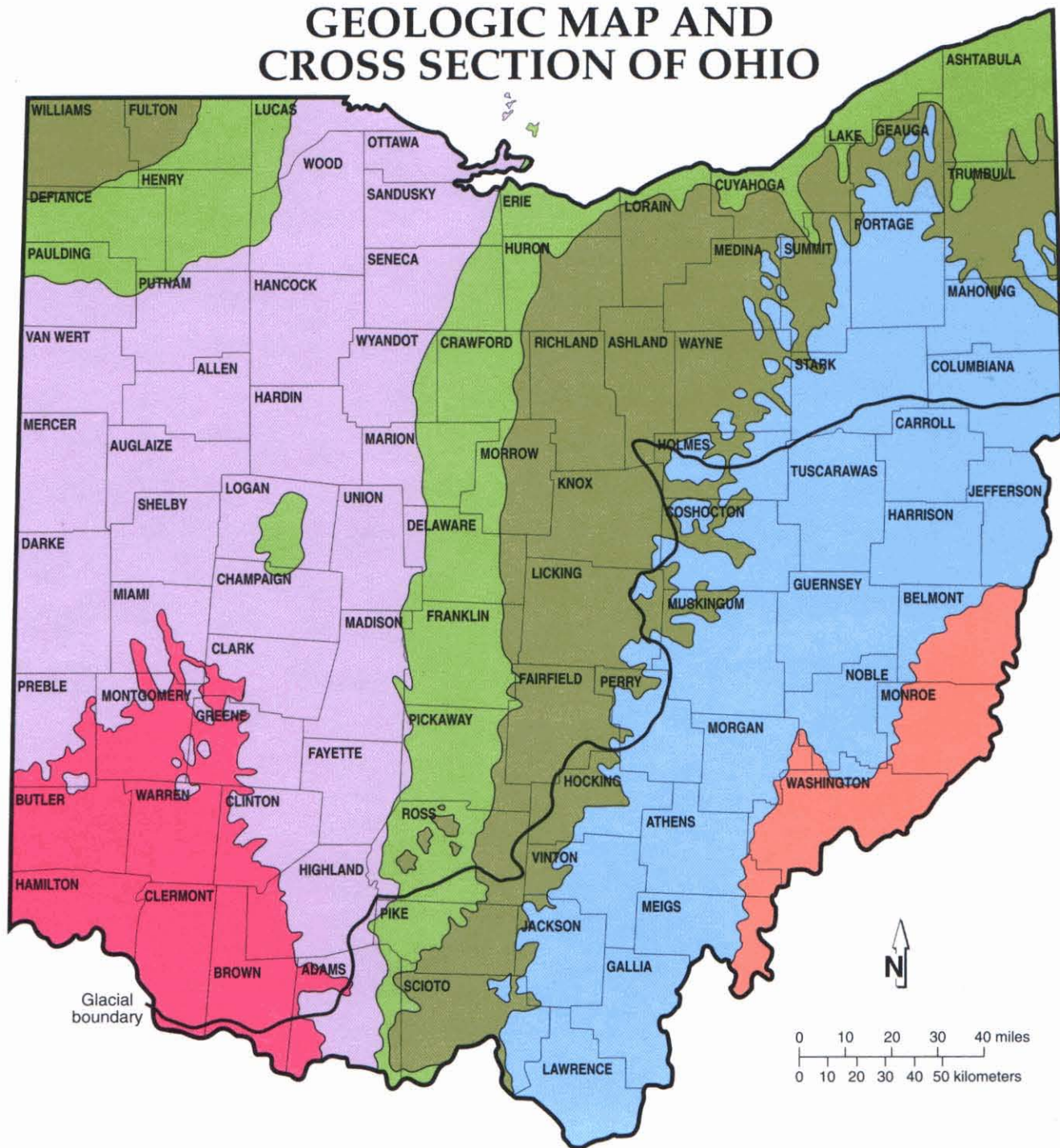
Pelecypod



Grammysia bisulcata

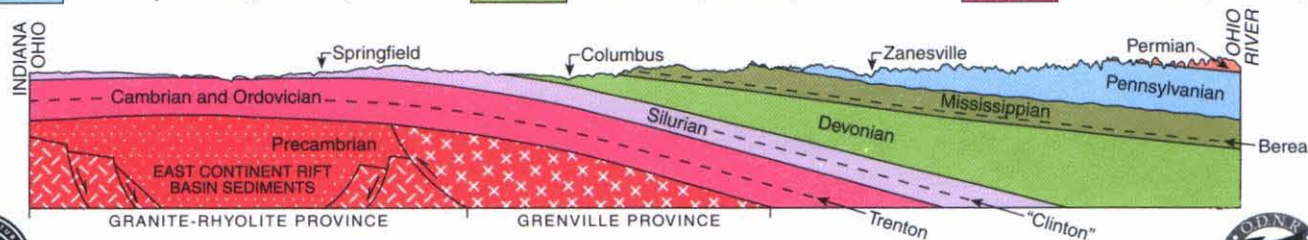
Fossils that can be found in Delaware Limestone. Figures taken from Stauffer, 1911.

GEOLOGIC MAP AND CROSS SECTION OF OHIO

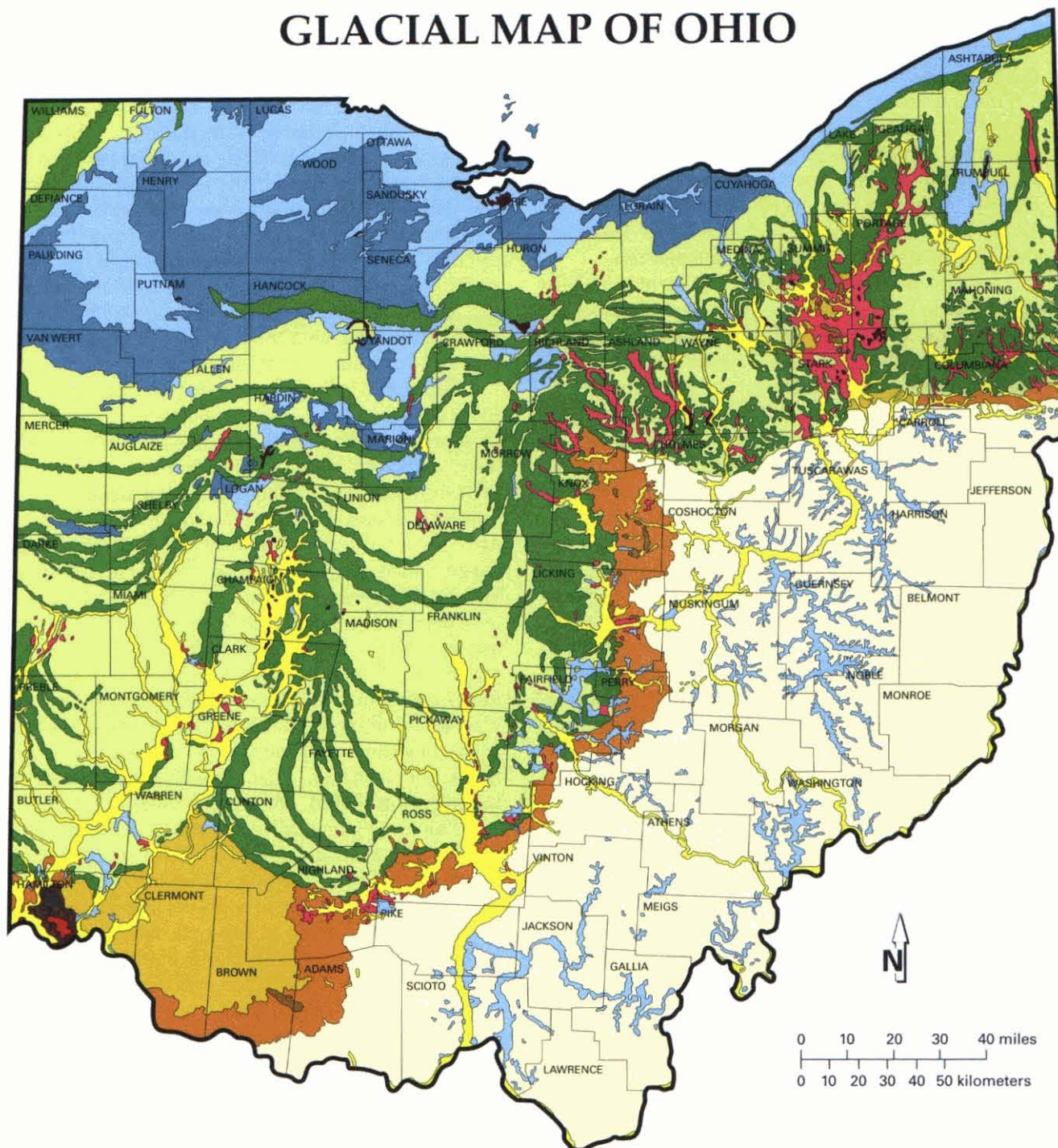


GEOLOGIC SYSTEM (million years before present)

 Permian (286-245)	 Mississippian (360-320)	 Silurian (438-408)
 Pennsylvanian (320-286)	 Devonian (408-360)	 Ordovician (505-438)



GLACIAL MAP OF OHIO



WISCONSINAN
(14,000 to 24,000 years old)

- Ground moraine
- Wave-planed ground moraine
- End moraine

ILLINOIAN
(130,000 to 300,000 years old)

- Ground moraine
- Dissected ground moraine
- Hummocky moraine

PRE-ILLINOIAN
(older than 300,000 years)

- Ground moraine
- Dissected ground moraine

- Kames and eskers
- Outwash
- Lake deposits
- Peat
- Colluvium



GLACIAL DEPOSITS OF OHIO

Although difficult to imagine, Ohio has at various times in the recent geologic past (within the last 1.6 million years) had three-quarters of its surface covered by vast sheets of ice perhaps as much as 1 mile thick. This period of geologic history is referred to as the Pleistocene Epoch or, more commonly, the Ice Age, although there is abundant evidence that Earth has experienced numerous other ice ages throughout its 4.6 billion years of existence.

Ice Age glaciers invading Ohio formed in central Canada in response to climatic conditions that allowed massive buildups of ice. Because of their great thickness, these ice masses flowed under their own weight and ultimately moved south as far as northern Kentucky. Oxygen-isotope analysis of deep-sea sediments indicates that more than a dozen glaciations occurred during the Pleistocene. Portions of Ohio were covered by the last two glaciations, known as the Wisconsinan (the most recent) and the Illinoian (older), and by an undetermined number of pre-Illinoian glaciations.

Because each major advance covered deposits left by the previous ice sheets, pre-Illinoian deposits are exposed only in extreme southwestern Ohio in the vicinity of Cincinnati. Although the Illinoian ice sheet covered the largest area of Ohio, its deposits are at the surface only in a narrow band from Cincinnati northeast to the Ohio-Pennsylvania border. Most features shown on the map of glacial deposits of Ohio are the result of the most recent or Wisconsinan-age glaciers.

The material left by the ice sheets consists of mixtures of clay, sand, gravel, and boulders in various types of deposits of different modes of origin. Rock debris carried along by the glacier was deposited in two principal fashions, either directly by the ice or by meltwater from the glacier. Some material reaching the ice front was carried away by streams of meltwater to form outwash deposits. Material deposited by water on and under the surface of the glacier itself formed features called kames and eskers, which are recognized by characteristic shapes and composition. A distinctive characteristic of glacial sediments that have been deposited by water is that the material was sorted by the water that carried it. Thus, outwash, kame, and esker deposits normally consist of sand and gravel. The large boulder-size particles were left behind and the smaller clay-size particles were carried far away, leaving the intermediate gravel- and sand-size material along the stream courses.

Material deposited directly from the ice was not sorted and ranges from clay to boulders. Some

of the debris was deposited as ridges parallel to the edge of the glacier, forming terminal or end moraines, which mark the position of the ice when it paused for a period of time, possibly a few hundred years. When the entire ice sheet receded because of melting, much of the ground-up rock material still held in the ice was deposited on the surface as ground moraine. The oldest morainic deposits in Ohio are of Illinoian and pre-Illinoian age. Erosion has significantly reduced these deposits along the glacial boundary, leaving only isolated remnants that have been mapped as dissected ground moraine and hummocky moraine.

Many glacial lakes were formed in Ohio during the Ice Age. Lake deposits are primarily fine-grained clay- and silt-size sediments. The most extensive area of lake deposits is in northern Ohio bordering Lake Erie. These deposits, and adjacent areas of wave-planed ground moraine, are the result of sedimentation and erosion by large lakes that occupied the Erie basin as Wisconsinan-age ice retreated into Canada. Other lake deposits accumulated in stream valleys whose outlets were temporarily dammed by ice or outwash. Many outwash-dammed lake deposits are present in southeastern Ohio far beyond the glacial boundary. Peat deposits are associated with many lake deposits and formed through the accumulation of partially decayed aquatic vegetation in oxygen-depleted, stagnant water.

The term glacial drift commonly is used to refer to any material deposited directly (*e.g.*, ground moraine) or indirectly (*e.g.*, outwash) by a glacier. Because the ice that invaded Ohio came from Canada, it carried in many rock types not found in Ohio. Pebbles, cobbles, and boulders of these foreign rock types are called erratics. Rock collecting in areas of glacial drift may yield granite, gneiss, trace quantities of gold, and very rarely, diamonds. Most rocks found in glacial deposits, however, are types native to Ohio.

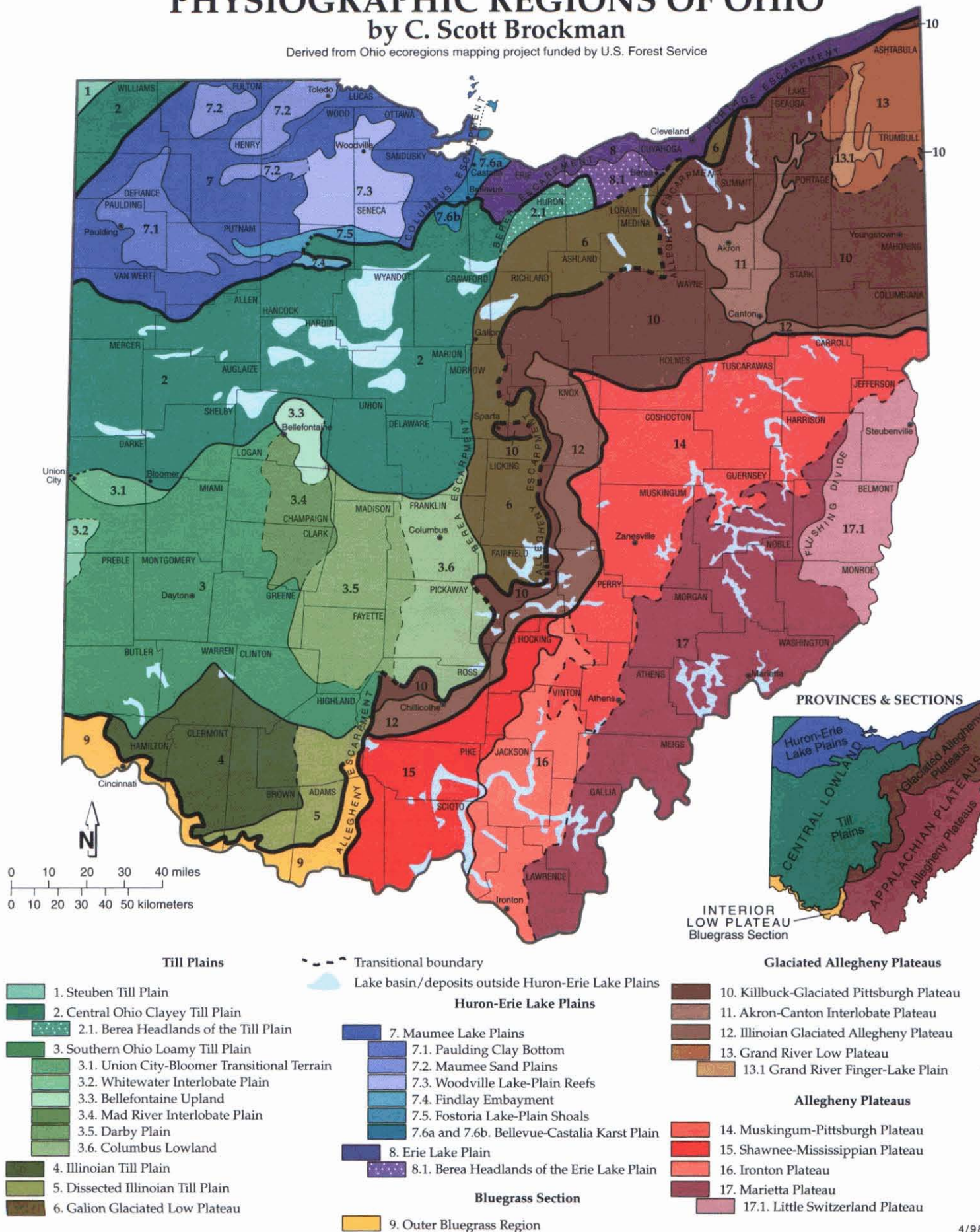
Certain deposits left behind by the ice are of economic importance, particularly sand and gravel, clay, and peat. Sand and gravel that have been sorted by meltwater generally occur as kames or eskers or as outwash along major drainageways. Sand and gravel are vital to Ohio's construction industry. Furthermore, outwash deposits are among the state's most productive sources of ground water.

Glacial clay is used in cement and for common clay products (particularly brick). The minor quantities of peat produced in the state are used mainly for mulch and soil conditioning.

PHYSIOGRAPHIC REGIONS OF OHIO

by C. Scott Brockman

Derived from Ohio ecoregions mapping project funded by U.S. Forest Service



PHYSIOGRAPHIC REGIONS OF OHIO

Major Divisions	INTERIOR PLAINS			APPALACHIAN HIGHLANDS	
	Provinces	Sections *	CENTRAL LOWLAND	APPALACHIAN PLATEAUS	
				Bluegrass Section	Allegheny (Kanawha) Plateaus
DISTINGUISHING CHARACTERISTICS OF REGIONS & DISTRICTS				GEOLOGY	BOUNDARIES
Till Plains	1. Steuben Till Plain. Hummocky terrain with rolling hills, interspersed flats and closed depressions; wetlands, few streams, deranged drainage; only a small part of the region is in Ohio, elevation 950'-1100', moderately low relief (60')			Wisconsinan-age (latest Ice-Age) loamy till from a northern source (Saginaw glacial lobe) over Mississippian-age Coldwater Shale	Southeast: edge of Wabash Moraine
	2. Central Ohio Clayey Till Plain. Surface of clayey till; well-defined moraines with intervening flat-lying ground moraine and intermorainal lake basins; no boulder belts; about a dozen silt-, clay- and till-filled lake basins range in area from a few to 200 square miles; few large streams; limited sand & gravel outwash; elevation 700'-1150', moderate relief (100')			Clayey, high-lime Wisconsinan-age till from a northeastern source (Erie glacial lobe) and lacustrine materials over Lower Paleozoic-age carbonate rocks and, in the east, shales; loess thin to absent	North: Lake Plain; northeast: limit of Berea Sandstone; east: Berea Escarpment; south: Powell and Union City/Bloomer Moraines; northern segment boundaries: Wabash Moraine and lake plain
	2.1. Berea Headlands of the Till Plain. Gently rolling to flat terrain of thin drift descending to Lake Erie; punctuated by more than 20 streamlined "whalebacks" of Berea Sandstone, 0.5 to 2.5 miles long, 30'-60' high; somewhat poorly drained; elevation 800'-1000', low relief (20')			Thin, clayey, medium-lime Wisconsinan-age till over resistant Mississippian-age Berea Sandstone	South: limit of Berea Sandstone; elsewhere: Berea Escarpment and/or margin of highest Pleistocene lake
	3. Southern Ohio Loamy Till Plain. Surface of loamy till, cut and recessional moraines, commonly associated with boulder belts, between relatively flat-lying ground moraine, cut by steep-valleyed large streams; stream valleys filled with outwash and alternate between broad floodplains and narrow; buried valleys common; elevation 530'-1150', moderate relief (200')			Loamy, high-lime Wisconsinan-age till, outwash, and loess over Lower Paleozoic-age carbonate rocks and, in the east, shales	East: Berea and Allegheny Escarpments; north: Powell and Union City/Bloomer Moraines; south: limit of Wisconsinan-age till
	3.1. Union City-Bloomer Transitional Terrain. Well-defined moraines with low-relief, hummocky ground moraine like the Central Ohio Clayey Till Plain to the north; loamy till with loess cap like Southern Ohio Loamy Till Plain to the south; elevation 920'-1075', moderately low relief (30')			Loamy, high-lime Wisconsinan-age till with thin loess cap over Silurian-age dolomites	North: Bloomer Moraine and limit of loamy till; south: Union City Moraine
	3.2. Whitewater Interlobate Plain. An upland between two converging glacial lobes with hummocky moraines, moraine complexes, kames, boulder belts, and broad outwash trains/plains; contains highest elevations in Indiana (1257') and in adjacent Ohio counties (1240'); elevation in Ohio 980'-1240', moderate relief (150')			Loamy, high-lime Wisconsinan-age till and sand and gravel outwash over resistant Silurian-age carbonate rocks (north) and less resistant Ordovician-age shales and limestones (south)	North: limit of Knightstown/Farmersville Moraines and kame fields; east: high, dissected hills draining to Whitewater River
	3.3. Bellevue Upland. Moderately high relief (250') dissected topography with moraine complexes, boulder belts, high-gradient major streams, caves and sinkholes; few glacial depressions/kettles compared to surrounding areas; elevation 1100'-1549', includes highest elevation in Ohio (Campbell Hill, 1549')			Loamy, high-lime Wisconsinan-age till over generally deeply buried Silurian- to Devonian-age carbonate rocks and Ohio Shale	North: areas with hilltops above 1200'; elsewhere: hilltops above about 1300'
	3.4. Mad River Interlobate Plain. Area between two major converging glacial lobes with extensive outwash, outwash terraces, and bordering moraines; springs and cool, ground-water-fed surface waters; elevation 800'-1350', moderate relief (200')			Loamy, high-lime Wisconsinan-age till and sand and gravel outwash over Silurian- to Devonian-age carbonate rocks and Ohio Shale	East and north: rear edge of Cable Moraine Complex; south: outwash to Clifton Gorge; west: western edge of Mad River Outwash
	3.5. Darby Plain. Moderately low relief (25'), broadly hummocky ground moraine with several broad, indistinct recessional moraines; between hummocks are broad, poorly drained swales which held wet prairies/meadows in pioneer days; few large streams; elevation 750'-1100'			Loamy, high-lime Wisconsinan-age till and sparse outwash over Silurian- and Devonian-age carbonate rocks and Ohio Shale in the southeast	South and west: front of Reesville and rear of Cable Moraines; north: Powell Moraine; east: increasing eastward slope (see 3.6)
	3.6. Columbus Lowland. Lowland surrounded in all directions by relative uplands, having a broad regional slope toward the Scioto Valley; many larger streams; elevation 600'-850' (950' near Powell Moraine), moderately low relief (25')			Loamy, high-lime (west) to medium-lime (east) Wisconsinan-age till and extensive outwash in Scioto Valley over deep Devonian- to Mississippian-age carbonate rocks, shales, and siltstones	North: Powell Moraine; east and south: Berea and/or Allegheny Escarpments; west: flatter and higher Darby Plain
	4. Illinoian Till Plain. Rolling ground moraine of older till generally lacking ice-constructional features such as moraines, kames, and eskers; many buried valleys; modern valleys alternating between broad floodplains and bedrock gorges; elevation 600'-1100', moderately low relief (50')			Silt-loam, high-lime, Illinoian-age till with loess cap; soils leached several feet; underlain by Ordovician- and Silurian-age carbonate rocks and calcareous shales	North: Wisconsinan glacial margin (Cuba and Hartwell Moraines); elsewhere: limit of common till-covered hillslopes
	5. Dissected Illinoian Till Plain. Hilly former till plain in which glacial deposits have been eroded from many valley sides; relatively high stream density; elevation 600'-1340', moderate relief (200')			Hilltops of high-lime Illinoian-age till with loess cap; slopes of bedrock- and till-derived colluvium and Ordovician- and Silurian-age carbonate rocks and calcareous shales	East: maximum glacial margin; elsewhere: limit of general absence of till on hillslopes
	6. Galion Glaciated Low Plateau. Rolling upland transitional between the gently rolling Till Plain and the hilly Glaciated Allegheny Plateau; mantled with thin to thick drift; elevation 800'-1400', moderate relief (100')			Medium- to low-lime Wisconsinan-age till over Mississippian-age shales and sandstones	North: limit of Berea Sandstone; west: Berea Escarpment; south and east: Allegheny Escarpment
	7. Maumee Lake Plains. Flat-lying Ice-Age lake basin with beach ridges, bars, dunes, deltas, and clay flats; contained the former Black Swamp; slightly dissected by modern streams; elevation 570'-800', very low relief (5')			Pleistocene-age silt, clay, and wave-planed clayey till over Silurian- and Devonian-age carbonate rocks and shales	Northeast: Lake Erie; elsewhere: margin of highest Pleistocene lake
	7.1. Paulding Clay Basin. Nearly flat lacustrine plain; most clayey of all Lake Plain subregions; low-gradient, highly meandering streams; easily ponded soils; elevation 700'-725', extremely low relief (less than 5')			Pleistocene-age lacustrine clay over clay till and Silurian-age dolomites	Northeast: subdued ("drowned") remnant of Defiance Moraine; elsewhere: limit of lacustrine clay
	7.2. Maumee Sand Plains. Lacustrine plain mantled by sand; includes low dunes, inter-dunal pans, beach ridges, and sand sheets of glacial lakeshores; well to poorly drained; elevation 600'-800', very low relief (10')			Late Wisconsinan-age sand over clay till and lacustrine deposits; Silurian- and Devonian-age carbonate rocks and shales buried deeply.	Limit of sandy deposits and/or low dunes
	Huron-Erie Lake Plains	7.3. Woodville Lake-Plain Reefs. Very low relief (10') lacustrine plain with low dunes and lake-margin features, punctuated by more than 75 ancient bedrock reefs rising 10' to 40' above the level of the plain and ranging in area from 0.1 to 3.0 square miles; the oblong reefs are thinly draped with drift; elevation 600'-775'			Thin to absent Wisconsinan-age wave-planed clay till, lacustrine deposits, and sand over Silurian-age reefal Lockport Dolomite
7.4. Findlay Embayment. Very low relief (10'), broadly rolling lacustrine plain; embayment of ancestral Lake Erie in which relatively coarse lacustrine sediments collected; elevation 775'-800'			Silty to gravelly Wisconsinan-age lacustrine deposits and wave-planed clayey till over Silurian-age Lockport Dolomite	West: 775' beach ridge; north: Defiance Moraine; south: margin of highest Pleistocene lake level	
7.5. Fostoria Lake-Plain Shoals. Portion of the Defiance Moraine lightly eroded by shallow Lake Maumee with low north-south trending hillocks and shallow, closed depressions; many sandy areas; elevation 750'-825', low relief, decreasing westward (10'-15')			Silty to gravelly Wisconsinan-age lacustrine deposits and wave-planed clay till over deeply covered Silurian-age dolomite	South and east: unmodified Defiance Moraine; elsewhere: very low-relief lake plain	
7.6a and 7.6b. Bellevue-Castalia Karst Plain. Hummocky plain of rock knobs and numerous sinkholes, large solution features, and caves; large springs; thinly mantled by drift; region straddles both Lake Plain (7.6a) and Till Plain (7.6b); 7.6a has greatest relief of any Lake Plain region (25'); elevation 570'-825'			Columbus and Delaware Limestones overlain by thin clay till in 7.6b, and thin silty and sandy Wisconsinan-age lacustrine deposits and wave-planed clay till in 7.6a	Limit of thinly mantled Columbus and Delaware Limestones, which is marked in the west by the Columbus Escarpment	
8. Erie Lake Plain. Edge of very low-relief (10') Ice-Age lake basin separated from modern Lake Erie by shoreline cliffs; major streams in deep gorges; elevation 570'-800'			Pleistocene-age lacustrine sand, silt, clay, and wave-planed till over Devonian- and Mississippian-age shales and sandstones	North: Lake Erie; south: margin of highest Pleistocene lake	
8.1 Berea Headlands of the Erie Lake Plain. Portion of the Erie Lake Plain underlain by resistant Berea Sandstone; several large sandstone headlands jut into the Ice-Age lake basin; contains several streamlined "whalebacks" of Berea Sandstone, 0.5 to 2.0 miles long, 20'-35' high; poorly drained; elevation 670'-800', very low relief (10')			Thin lacustrine deposits over thin, wave-planed, clayey, medium-lime Wisconsinan-age till; underlain by resistant Berea Sandstone	North: portion of Lake Plain underlain by soft shales; south: margin of highest Pleistocene lake	
9. Outer Bluegrass Region. Moderately high relief (300') dissected plateau of carbonate rocks; in east, caves and other karst features relatively common; in west, thin, early drift caps narrow ridges; elevation 455'-1120'			Ordovician- and Silurian-age dolomites, limestones, and calcareous shales; thin pre-Wisconsinan drift on ridges in west; silt-loam colluvium	Eastern segment: maximum glacial margin and high eastern ridges capped by noncarbonate rocks; connected by Ohio River bluffs to western segment which is bounded by nondissected till plain	
10. Killbuck-Glaciated Pittsburgh Plateau. Ridges and flat uplands generally above 1200', covered with thin drift and dissected by steep valleys; valley segments alternate between broad drift-filled and narrow rock-walled reaches; elevation 600'-1505', moderate relief (200')			Thin to thick Wisconsinan-age clay to loam till over Mississippian- and Pennsylvanian-age shales, sandstones, conglomerates and coals	West and north: resistant sandstones of the Allegheny and Portage Escarpments; south and east: Wisconsinan glacial margin	
11. Akron-Canton Interlobate Plateau. Hummocky area between two converging glacial lobes dominated by kames, kame terraces, eskers, kettles, kettle lakes, and bogs/fens; deranged drainage with many natural lakes; elevation 900'-1200', moderate relief (200')			Sandy Wisconsinan-age and older drift over Devonian- to Pennsylvanian-age sandstones, conglomerates and shales	Limit of common, sandy ice-contact features and deposits	
12. Illinoian Glaciated Allegheny Plateau. Dissected, rugged hills; loess and older drift on ridgetops, but absent on bedrock slopes; dissection similar to unglaciated regions of the Allegheny Plateau; elevation 600'-1400', moderate relief (200')			Colluvium and Illinoian-age till over Devonian- to Pennsylvanian-age shales, siltstones and sandstones	North and west: Wisconsinan glacial margin; south and east: Illinoian (maximum) glacial margin	
Glaciated Allegheny (Southern New York) Plateaus	13. Grand River Low Plateau. Gently rolling ground and end moraine having thin to thick drift; poorly drained areas and wetlands relatively common; elevation 760'-1200', low relief (20') except near Grand River Valley (200')			Clayey, low-lime Wisconsinan-age till over deeply buried, soft Devonian-age shales and near-surface Mississippian-age sandstones and shales	North: Portage Escarpment; south and west: Defiance Moraine; southeast: increasing relief from proximity of buried Pennsylvanian-age sandstones
	13.1. Grand River Finger-Lake Plain. Very low relief (10') lake deposits in steep-sided troughs (200' relief) within the Grand River Low Plateau; cut by glacial and stream erosion; extensive wetlands; elevation 800'-900'			Surficial lacustrine clay and drift over deeply buried, soft Devonian-age shales	Margins of steeply sloping troughs containing the Grand River and parts of Rock and Mosquito Creeks
	14. Muskingum-Pittsburgh Plateau. Moderately high to high relief (300'-600') dissected plateau having broad major valleys that contain outwash terraces, and tributaries with lacustrine terraces; medium-grained bedrock sequences coarser than those in Marietta Plateau (17) but finer than those in Ironton Plateau (16); remnants of ancient Teays-age drainage system uncommon; elevation 650'-1400'			Mississippian and Pennsylvanian-age siltstones, shales, sandstones and economically important coals and claystones; Wisconsinan-age sand, gravel, and lacustrine silt; silt-loam colluvium	North and west: maximum glacial margin; southeast: transition to finer grained bedrock; southwest: transition to coarser grained bedrock
	15. Shawnee-Mississippian Plateau. High relief (400'-800'), highly dissected plateau of coarse and fine grained rock sequences; most rugged area in Ohio; remnants of ancient lacustrine clay-filled Teays drainage system are extensive in lowlands, absent in uplands; elevation 490'-1340'			Devonian- and Mississippian-age shales, siltstones, and locally thick sandstones; Pleistocene-age sandy outwash in Scioto River; Teays-age Minford Clay; silt-loam and channelry colluvium	North: Maximum glacial margin; west: carbonate bedrock; east: limit of Mississippian-age bedrock
	16. Ironton Plateau. Moderately high relief (300') dissected plateau; coarser grained coal-bearing rock sequences more common than in other regions of the Allegheny Plateau; common lacustrine clay-filled Teays Valley remnants; elevation 515'-1060'			Pennsylvanian-age (Pottsville, Allegheny and Conemaugh Groups) cycles of sandstones, siltstones, shales and economically important coals; Pleistocene (Teays)-age Minford Clay; silt-loam and channelry colluvium	West: limit of common Pennsylvanian-age bedrock; north and east: gradation to finer rock sequences
	17. Marietta Plateau. Dissected, high-relief (generally 350', to 600' near Ohio River) plateau; mostly fine-grained rocks; red shales and red soils relatively common; landslides common; remnants of ancient lacustrine clay-filled Teays drainage system common; elevation 515'-1400'			Pennsylvanian-age Upper Conemaugh Group through Permian-age Dunkard Group cyclic sequences of red and gray shales, and siltstones, sandstones, limestones and coals; Pleistocene (Teays)-age Minford Clay; red and brown silty-clay loam colluvium; landslide deposits	North and west: transition to medium-grained Lower Conemaugh rocks; east: Flushing Divide
	17.1. Little Switzerland Plateau. Highly dissected, high-relief (generally 450', to 750' along Ohio River) plateau; mostly fine-grained rocks; red shales and red soils relatively common; landslides common; high-gradient shale-bottomed streams subject to flash flooding; no remnants of ancient Teays drainage system; elevation 540'-1400'			Similar to Marietta Plateau but lacking Pleistocene (Teays)-age Minford Clay	North: transition to medium-grained rocks; west and south: Flushing Divide; east: Ohio River

* Section names modified from Fenneman (1938, 1946).